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"Physician Productivity, Remuneration Method and Supplier-Induced Demand"

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EXECUTIVE SUMMARY

The primary objective of this research is an increased understanding of how remuneration methods affect physicians' work behavior. The purpose of the research is to provide the Health Care Financing Administration (HCFA) with an improved ability to increase the efficiency and quality of medical care under Medicare and Medicaid. Although the funding authority for this group of investigations is directed at improvements in Medicare's Economic Index, the research in this first contract year focuses on the more fundamental and underlying issues of how each of the alternative financial incentives affect physicians' production of medical care, income, and use of practice inputs.

The research has three major methods. The first is a conceptual and microeconomic model of physicians' work and leisure behavior. The second is an estimate of the effects of remuneration among other determinants of income and practice inputs using the HCFA Survey of Physician Practice Costs and Income. The third is an estimate of physician production functions using the same HCFA Survey.

In the microeconomic model, three conceptually pure remunerations are defined and considered. The first pays the physician a fixed income regardless of his medical and/or nonmedical activities. The second provides an income proportional to the physician's time at work. The third pays the physician an amount proportional to the medical care he delivers. Hypotheses about physicians' income, efficiency, time at work, and use of practice inputs time are derived for each of three alternative market equilibria.

By recognizing that salary income is a combination of time-based and fixed incomes and that fee-for-service income is a combination of time- and output-based incomes, analysis of the model yields a series of observable hypotheses.

1. Salaried physicians should represent a very small proportion of the total number of physicians. This hypothesis corresponds to the dynamic equilibrium for our model with remuneration type as an endogenous variable.

2. Compared with fee-for-service physicians, the salaried doctors should earn less gross income.

3. Compared with fee-for-service physicians, the salaried doctors should work fewer hours.

4. Compared with fee-for-service physicians, the salaried doctors should have lower practice expenses.

5. Compared with fee-for-service physicians, the salaried doctors should produce less medical care.

Considerable support for these hypotheses is developed from the empirical estimates of the effects of remuneration of physicians' incomes and practice inputs. Salaried physicians do represent a very small percent of the total physicians, do earn less gross income, and do have lower deductible medical expenses. No significant differences are found between the salaried and the fee-for-service physicians' production of medical care as measured by the number of office or hospital visits.

The one unanticipated result is the longer work hours of one small group of salaried physicians, those employed by a single physician. This anomaly may be explained by the fact that these employees are probably young doctors who are working hard to build their reputation and skills before joining the practice as a partner.

Other empirical results include:

1. low gross and net incomes of female physicians which are not fully explained by their smaller number of office and hospital visits per week,

2. negative but insignificant effects of physician densities on individual physician income, and

3. positive effects of hospital bed densities on physician incomes.

The production function estimates of the third section of the research confirm the primary importance of physicians' time in office-based medical care. Other significant inputs include expenditures on materials and supplies and non-physician medical personnel hours.

Comparisons between production function estimates in high and low physician density areas suggest that physicians in the low density areas are substituting medical materials and supplies (such as drugs, biologicals, and X-rays) for their own time.

INTRODUCTION

In 1978 physicians received $5.5 billion from Medicare and $1.1 billion from Medicaid [36]. As administrator of these federal funds, the Health Care Financing Administration (HCFA) has a mission to "promote efficiency and quality within the health delivery system." Indeed, "reform and control of reimbursement" to improve quality, increase access, and hold down costs have been key HCFA priorities [44].

The objective of this research is an increased understanding of one aspect of reimbursement, physician remuneration methods. That physicians play a central role in determining all medical care expenditures is well recognized [24, 30]. Yet the implications of different types of doctors' incomes are imperfectly understood. We seek to explain how alternative remuneration methods (not dollar amounts) affect physicians' income and use of practice inputs.

Different physician remuneration methods are of particular interest because they afford the prospect of generating quality and cost improvements through decentralized market incentives. Direct regulations are increasingly criticized for their unanticipated long term cost increases and perverse economic disincentives. Specifically, alternative physician remunerations offer the possibility of achieving the cost containment objectives of the Economic Index without the potential hazards of direct regulations.

The research described herein has three separate methods which are reported in separate sections. In the first, we develop mathematical solutions to microeconomic model of physicians work (and leisure) decisions. In the second, we use the 1976 Office-Based Physician Practice Cost Survey by HCFA and the National Opinion Research Center to test the hypotheses of the mathematical model and of supplier-induced demand. In the third, we use the same data to estimate physicians' production functions for high and low physician density areas.

In the remaining sections of this Introduction, we describe the research objectives, indicate why physician remuneration is important, and review conceptual and actual remuneration alternatives.

Research Objectives

The objectives of the first section are to identify the incentives which are inherent in four conceptually pure remuneration alternatives, fixed income and time-, output-, and patient-based incomes.[1] From these results we derive a series of empirically testable hypotheses about the effects of alternative remuneration methods on physician income, use of practice inputs, and productivities. Despite physicians' central role in all health care decisions, very little is known about their sensitivity to financial incentives. The objectives of this section are to specify a model capable of identifying a wide range of factors which impinge on, and result from, physicians' work-leisure decisions. The objectives are also to solve this model to predict the direction of impact of different remuneration types on physician income, time at work, use of practice inputs, and productivity. Both the model and the solutions are designed to contribute to the conceptual understanding of how financial incentives affect physicians' health care delivery decisions.

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[1] These remuneration alternatives are explained and compared with actual physician compensation methods in the next sections of the Introduction.

The objectives of the second section are to estimate the impacts of both remuneration method and medical resource density on physicians income, use of practice inputs, and productivities. These objectives include estimates of how remuneration methods affect physicians' time at work and use of practice inputs. Two groups of specific questions are to be answered.

1. Are the model's hypotheses about the effects of remuneration methods on physicians' incomes, work times, use of practice inputs, and productivities supported by observed differences derived from the HCFA/NORC Survey of Physician Practice Costs? Are these observed effects large? Are there other explanations for the observed differences? What impact would each remuneration method considered in the sample have on the nation's health care costs if it were universally applied?

2. How do physicians' incomes and use of practice inputs respond to demands created by high per capita incomes and large populations in their areas? How are physicians'incomes and use of practice inputs affected by high physician and hospital bed densities? High surgery rates, hospitalization rates, and physician visits have been attributed to the density of surgeons, hospital beds, and physicians in the area. This research seeks additional insight to these correlations by comparing the effects of medical resource densities, incomes, and populations as determinants of physicians' incomes, work time, practice inputs, and productivities.

The third section objectives are to examine directly physicians' production of medical care. Our objectives are to estimate the extent to which each of the various practice inputs contribute to the production of medical care for patients. We also seek insight into the difference in physician productivities between areas with low versus high medical resource densities.

Remuneration Importance

Physician remuneration methods are recognized as having some effect on physician productivity and resource use. In prepaid group practices there are substantially lower hospitalization rates, which lower the combined out-of-pocket and premium costs by 10% to 40% [55]. But the cost reductions do not occur in Foundation HMO's and are affected by the risk assumed by the physician and by peer review [35]. Perkoff [66] finds HMO costs are not uniformly lower than equivalent fee-for-service expenditures.

Conventional wisdom also recognizes the potential effects of new alternative remunerations. Recent suggestions for alternative remuneration methods include suggestions that the Medicare formula be scrapped because of its inflationary impact [15] and the Institute of Medicine's suggestion that specialists and primary physicians basically be paid equal fees [20].

Despite empirical estimates of overall expenditure savings per capita and the attention directed to alternatives to fee-for-service remuneration, neither theoretical models nor empirical tests have examined productivity of detailed resource utilization as a function of alternative remuneration method. In their path-breaking works, Evans [24], Feldstein [29], Glaser [37 and 38], and Pauly [65] have cited the importance of remuneration methods. Nevertheless, there is a need for more rigorously specified models which can verify, or at times challenge, intuition.

Alternative Remunerations

This research considers the effects of two groups of remuneration alternatives, a set of conceptually pure remunerations and a set of real-world remunerations. There are four alternatives in the set of conceptually pure variations. These are incomes which are fixed regardless of the physician's activities and incomes which are proportional to the physician's patient contact time, the number of patients in his care, and his production of medical care. We call these fixed, time-based, patient-based, and output-based incomes. The microeconomic model developed and reported in the next section generates a number of unambiguous income and practice input results for these different types of income. These results form a solid foundation for predicting the effects of the more complicated real-world remunerations.

The transition from the conceptually pure to the real-world alternatives is not straightforward. The well-known fee-for-service remuneration does not exactly correspond to either time- or output-based income. For example, Dr. Esselstyn cites the similarities between fee-for-service and output-based income [19]. In contrast, Dr. Hughes has reported the high correlation between the units of the California Relative Value Scale and surgeons time inputs [48]. Similarly salary incomes are to some degree fixed, yet depend upon (or may require a certain amount of) the physician's work time. Salaries may even have some relation to a physician's expected productivity.

For the purposes of the transition from the conceptual to the real-world, we presume that the fees of a fee-for-service system are determined by both the physician's time and by the medical care he produces. Similarly, we assume that salary is some mix of fixed income and time-based income. We further presume that capitation or prepayment refers corresponds to patient-based income and that case rates are approximated by output-based income.

While these definitions do capture some of the key remuneration characteristics which will affect physician behavior, they are not presented as more than useful characterizations. One qualification which is particularly evident is that a physician receiving a salary is an employee, while a physician paid fees for his services is more like an independent contractor. The income of salaried employees is less affected by fluctuating demand. The practice inputs of salaried employees are significantly determined by an employer. The policy implications of these qualifications are to be developed in future research.

A second qualification results from the difficulty encountered when operationalizing output. The research reported in the next section will develop the optimality of output-based income. Unfortunately, the application of these principles to case rate income is confounded by the lack of an appropriate operational output definition which would generate equity across cases.

Summary

Despite these qualifications, the microeconomic modeling has policy relevance and is more than a pedantic exercise. Exactly because the real world remuneration methods are not straightforward, we need to understand the separate effects of each characteristic of the real world. Furthermore and to the extent that fee-for-service physicians' time allocations, productivities, and use of practice inputs most closely approximate the pattern predicted by time-based income, we can support Hughes' hypothesis. To the extent that fee-for service patterns correspond to the output-base income, we can support the Esselstyn hypothesis.

At the same time, the empirical research is also a source of ideas which feed back insight into the applications of the microeconomic model. The empirical results reported below make significant progress in our understanding of "supplier-induced demand."

MICROECONOMIC MODEL OF PHYSICIAN WORK (AND LEISURE) BEHAVIOR

Whether we call them "consumer agents" [24] or "team captains" [30], physicians significantly determine each patient's expenditures and use of medical care resources. This insight, coupled with this Nation's rapidly rising medical care expenditures, has generated a growing body of literature on factors, such as physician remuneration, which affect the physician's efficient use of medical care resources.

As the administrator of public expenditures on medical care, HCFA needs to thoroughly understand the effects of physician remuneration on delivered medical care. The model presented below develops one important component of that understanding: a conceptual model of physician work and leisure decisions. Such an exercise is useful to HCFA because it develops the logical consequences of a series of reasonable assumptions. These assumptions and their consequences then become a standard by which actual remunerations and empirical observations may be compared.

Despite the growing scholastic interest, models which thoroughly represent the effects of more than two alternative remunerations are scarce, even within usually rigorous economic manuscripts. The well-known time allocation between income and leisure ignores the role of practice inputs other than the physician's labor. The profit maximization model can only compare output-based and fixed incomes. Neither model, nor any modification based on the unmeasureable "work effort," is capable of a full comparision of the effects of fixed, time-, and output-based incomes.

More specifically, none of the better empirical modeling efforts, including adaptations of textbook income-leisure models [70 and 78], production functions [53 and 70], cost functions [78], or demand and supply equations [40], is able to demonstrate the effect of a broad range of remuneration methods. For example, Reinhardt's [70] inclusion of office personnel and practice mode and Sloan and Cromwell's [78] employment amenities are steps in the right direction, but their income-leisure models fail to recognize both professional and leisure objectives and do not incorporate either work or leisure production activities. The remaining techniques simply have not been applied to analyses of remuneration methods.

Actually, the effects of alternative remuneration methods are most directly examined outside of the medical literature. In the context of the economic literature on sharecropping, Chueng [11] and Olson [64] use overly simplistic income-leisure models to assert that the method of remuneration has no effects on the use of resources or on productivity. Stiglitz [83 and 84] does find remuneration method important because sharecropping forces the tenant to assume some of the risk of the uncertain crop production.

More to the point, the effects of wage and piece rate incomes are compared in a recent manuscript [90] of the Principal Investigator. In this study, data from the November 1970 Current Population Survey and its Supplement indicate that machine operators paid a piece rate income are more productive (earn more per hour), work fewer hours per week, and are willing to accept a lower income per week. The research reported below seeks to provide similar comparisons for physicians under different remunerations.

Microeconomic Model

Our model presumes that each physician derives utility from professional activities, measured by medical care production V, and from the consumption of the product of his leisure activities Z.

$$U = U(V,Z) \tag{1}$$

where U is utility level,

V is total production of medical care,

Z is total production (and consumption) of leisure activities,

$U_V > 0$, and $U_Z > 0$.

The use of production of leisure activities rather than leisure time and net income in the utility function follows Becker[6]. Our assumption that a doctor derives satisfaction from his professional activity, measured by production of medical care, is less common. Scitovsky recognized the issue 27 years ago.

> Artists, scientists, professional people, and business men often regard their work not merely as a means of earning income but as an important and interesting part of their lives [72, p. 87].

More recently Enthoven has defined physicians' joint objectives.

> Physicians and other health professionals are motived by non-financial goals, including a desire to cure the sick and to achieve professional excellence and esteem of peers and public. But their use of resources is inevitably shaped by financial incentives [17].

Our model includes medical care output in the utility function as a direct representation of the first of Enthoven's professional objectives. Demonstrating exactly how financial incentives can shape physicians' use of resources is the main focus of this section of the research.

An exact definition of the medical care output V is unnecessary for this conceptual research. The usual empirical indexes of physicians' production, such as patient contacts or billings, are simply not good measures of changes in patients' health. Although Health Status Indexes ask the relevant questions, they are inadequately developed to be generally useful. In this theoretical section, medical care output V is assumed to be some undefined combination of improved patient characteristics, such as increased longevity, reduced pain or suffering, and increased psychological satisfaction. The purposes of this conceptual model are satisfied by assuming only that each physician behaves as if he or she understands the definition of medical care.[2] In the later empirical sections, we adopt one of the usual empirical output measures.

In a manner identical to Becker, we assume physicians produce leisure using consumer purchases x_z and their own time t_z.

(2) $Z = Z(x_z, t_z)$

where Z is production of leisure activities,

x_z is purchased consumer goods,

t_z is leisure time,

$Z_{x_z} > 0$, and $Z_{t_z} > 0$.

Of course, one of Becker's leisure activities could easily be work. By using such a specification, we have a work production function where output V is produced using intermediate market goods x_v and time t_v,

(3) $V = V(x_v, t_v)$

where V indicates the quantity of work output (medical care) produced,

x_v are quantities of (practice) inputs purchased with income,

t_v is the individual's (physician's) time at work,

$V_{x_v} > 0$, and $V_{t_v} > 0$.

By rewriting equation (3), we include patients as one of the necessary inputs in the production of medical care. This is a somewhat novel specification. Yet the similarity between patients and other factors of production is strong. Without patients the physicians cannot produce medical care. With larger numbers of patients, the productivity of each physician's time and practice inputs increases. Algebraically, the work production function is specified:

(4) $V = F(x_v, t_v, n)$

where V indicates total medical care production,

x_v indicates practice inputs,

---

[2] We assume that the marginal rate of technical substitution between quality and quantity levels is unaffected by remuneration method, ceteris paribus.

t_v indicates physician work time,

n indicates the number of patients,

$F_{x_v} > 0$, $F_{t_v} > 0$, and $F_n > 0$.[3]

The physician's behavior is constrained by his income and his time. In addition to work and leisure allocations of time and income, the physicians are assumed to spend a fixed amount of time administering, diagnosing, and processing each patient.[4] This effort produces no direct health care improvement and does not increase utility. Thus, the income and time constraints are

(5) $Y = x_v + x_z$ and

(6) $T = t_v + t_z + n.t_d$

where Y indicates gross physician real earnings, that is gross dollar earnings divided by the price of goods[5],

T is total time, and

t_d is the physician's administrative time to diagnose and process each patient.

In the context of this model, we consider the four conceputally pure remuneration alternatives described in the Introduction. Because our empirically observed remuneration alternatives do not correspond directly to any of the simple remuneration alternatives, we adopt the use of the somewhat pedantic 'fixed,' 'time-based,' 'output-based,' and 'patient-based' terminology. Later in the paper we derive empirically testable hypotheses from the assumption that salaries consist of a combination of time-based and fixed incomes and that fees-for-services are combinations of time and output-based remunerations.

The simplest income is fixed; the physician receives a predetermined remuneration per time period regardless of his labor or nonlabor activities during that period.

---

[3] We are choosing to ignore the interesting possibility that the marginal product of patients might be negative in physician sparce areas.

[4] We do not believe that the likely results of a model with diagnositic activities in the physician utility function justify the increased complexity of the solutions.

[5] We assume that consumption goods x_z and practice inputs x_v have been normalized so that their prices are equal, $p_{x_v} = p_{x_z}$.

(7) $Y = Y_f$

where Y_f is exogenously determined.

Wages are a second remuneration alternative, although physicians receive them infrequently. If MD's were paid wages, income would be directly proportional to their hours of work time.

(8) $Y = w.t_v$

where w is an exogenously determined wage rate.

Case rates refer to treatment of specific conditions, such as a normal delivery or setting a fracture, and most clearly correspond to a payment per unit of health care output. Such remuneration is fixed per unit of output regardless of the physician's time or use of machinery and equipment.

(9) $Y = P.V$

where P is an exogenously determined price per unit of health care output.

Capitation or prepayment gives the physician a fixed amount per person on a patient roster regardless of the medical services, if any, provided to the patient.

(10) $Y = p_n.n$

where p_n is fixed income per patient.

The general Lagrangian expression (which allows us to maximize physician's utility subject to two constraints) for this work-leisure model is

$$(11) \quad \pounds = U[Z(x_z,t_z), V(x_v, t_v, n)] + \lambda_t(T - t_z - t_v - n.t_d) + \lambda_x(Y - x_z - x_v)$$

where $Y = Y_f$, $Y = w.t_v$, $Y = P.V$, or $Y = p_n.n$

Mathematical Solutions

We have mathematical solutions for the two similar microeconomic models. In the first, we solved for the four remuneration alternatives introduced above. But when it became apparent that the 'prepaid' question on the data set was not usable, we dropped the solutions for the prepaid remuneration. In the first subsection below, we report the preliminary four-remuneration

Table 1

Comparative Characteristics of Physicians' Work-Leisure Decisions
Cobb-Douglas Functional Form with Constant Returns to Scale

Endog. Var.	Non-Labor Income	Time-Based Income	Output-Based Income	Patient-Based Income
t_z	$\frac{\alpha\gamma}{\alpha\gamma + (1-\delta)(1-\gamma)} T$	$\alpha\gamma T$	$\alpha\gamma T$	$\alpha\gamma T$
t_v	$\frac{\beta(1-\gamma)}{\alpha\gamma + (1-\delta)(1-\gamma)} T$	$[(\beta+\delta)(1-\gamma) + \gamma(1-\alpha)] T$	$\frac{\beta(1-\alpha\gamma)}{(1-\delta)} T$	$\beta(1-\gamma) T$
Y	Y_f	$w\ t_v$	$P_v\ V$	$P_n\ n$
x_z	$\frac{\gamma(1-\alpha)}{\delta(1-\gamma)+\gamma(1-\alpha)} Y_f$	$\frac{\gamma(1-\alpha)[(\beta+\delta)(1-\gamma)+\gamma(1-\alpha)]}{\delta(1-\gamma)+\gamma(1-\alpha)} wT$	$\frac{\gamma(1-\alpha)(1-\delta)}{(1-\alpha\gamma)-(1-\gamma)(1-\delta)} P_v V$	$P_n\{1-\beta(1-\gamma)-\alpha\gamma\} \left[\frac{\gamma(1-\alpha)}{\delta(1-\gamma)+\gamma(1-\alpha)}\right]$
x_v	$\frac{\delta(1-\gamma)}{\delta(1-\gamma) + \gamma(1-\alpha)} Y_f$	$\frac{\delta(1-\gamma)[(\beta+\delta)(1-\gamma) + \gamma(1-\alpha)]}{\delta(1-\gamma) + \gamma(1-\alpha)} wT$	$\frac{\delta(1-\alpha\gamma)}{(1-\alpha\gamma)-(1-\gamma)(1-\alpha)} P_v V$	$P_n\{1-\beta(1-\gamma)-\alpha\gamma\} \left[\frac{\delta(1-\gamma)}{\delta(1-\gamma)+\gamma(1-\gamma)}\right]$
n	$\frac{(1-\delta-\beta)(1-\gamma)}{\alpha\gamma+(1-\delta)(1-\gamma)} \frac{T}{t_d}$	$(1-\delta-\beta)(1-\gamma) \frac{T}{t_d}$	$\frac{(1-\delta-\beta)(1-\alpha\gamma)}{(1-\delta)} \frac{T}{t_d}$	$\{1-\beta(1-\gamma)-\alpha\gamma\} \frac{T}{t_d}$

model solutions. In the second subsection, we start again with a simplier three-remuneration model which is completely solved for three different dynamic market situations.

The Four Remuneration Model

The following Cobb-Douglas model with constant returns to scale has been solved for fixed, time-based, output-based, and patient-based remunerations.[6]

$$(12) \quad U = Z^{\gamma} V^{(1-\gamma)}$$

$$(13) \quad Z = t_z^{\alpha} x_z^{(1-\alpha)}$$

$$(14) \quad V = t_v^{\beta} x_v^{\delta} n^{(1-\beta-\delta)}$$

$$(15) \quad T = t_z + t_v + t_d \cdot n$$

$$(16) \quad Y = x_z + x_v$$

The Lagrangian for this model is

$$(17) \quad \pounds = t_z^{\gamma\alpha} x_z^{\gamma(1-\alpha)} t_v^{(1-\gamma)\beta} x_v^{(1-\gamma)\delta} n^{(1-\beta-\delta)} + \lambda_t(T - t_z - t_v - t_d \cdot n) + \lambda_x(Y - x_z - x_v)$$

where $Y = Y_f$, $Y = w.t_v$, $Y = P.V$, or $Y = p_n \cdot n$

Solutions to the utility maximzation model are obtained by taking the first partial differential of the Lagrangian for each of the dependent variables, setting each of those equations equal to zero, and then solving that series of equations for each of the dependent variables. The detailed first order conditions are reported in Appendix I.

Table 1 reports the basic mathematical solutions for the endogenous variables in this four-remuneration model.

The Three Remuneration Model

Because of a small number of observations on the patient-based remuneration, we solved a slightly simplier model for fixed, time-based, and output-based remunerations.

$$(18) \quad U = Z^{\gamma} V^{(1-\gamma)}$$

$$(19) \quad Z = t_z^{\alpha} x_z^{(1-\alpha)}$$

---

[6] While the Cobb-Douglas function form significantly simplifies the algebra, it may also introduce results which would not be robust for other functions. The implications of relaxing the unitary elasticity assumptions are considered at the end of this section.

Table 2

Endogenous Variable Solutions for Three Remunerations
Cobb-Douglas Model with Constant Returns to Scale

Endog. Var.	Fixed Income		Time Based Income		Output-Based Income
t_z	$\frac{\alpha\gamma T}{\alpha\gamma + \beta(1-\gamma)}$	$>$	$\alpha\gamma T$	$=$	$\alpha\gamma T$
t_v	$\frac{\beta(1-\gamma) T}{\alpha\gamma + \beta(1-\gamma)}$	$<$	$(1-\alpha\gamma) T$	$=$	$(1-\alpha\gamma)T$
x_z	$\frac{(1-\alpha)\gamma Y}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}$		$\frac{(1-\alpha)\gamma}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)} (1-\alpha\gamma)wT$		$\frac{(1-\alpha)\gamma\beta}{(1-\beta)} T[P(1-\alpha\gamma)]^{\frac{1}{\beta}} \left(\frac{1-\beta}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}}$
x_v	$\frac{(1-\beta)(1-\gamma) Y}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)}$		$\frac{(1-\beta)(1-\gamma)}{(1-\alpha)\gamma + (1-\beta)(1-\gamma)} (1-\alpha\gamma)wT$		$T P^{\frac{1}{\beta}} (1-\alpha\gamma)^{1+\frac{1}{\beta}} \left(\frac{(1-\beta)}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}}$
Y	Y		$(1-\alpha\gamma)wT$		$T[P(1-\alpha\gamma)]^{\frac{1}{\beta}} \left(\frac{(1-\beta)}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}-1}$
Z	$\left(\frac{\gamma\alpha T}{\alpha\gamma + \beta(1-\gamma)}\right)^{\alpha} \left(\frac{\gamma(1-\alpha)Y}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\alpha}$		$(\alpha\gamma T)^{\alpha} \left(\frac{(1-\alpha)\gamma(1-\alpha\gamma)wT}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\alpha}$		$(\alpha\gamma T)^{\alpha} \left\{ \frac{\gamma\beta(1-\alpha)T}{(1-\beta)} \left[\frac{P(1-\alpha\gamma)(1-\beta)}{(1-\beta)+\gamma(\beta-\alpha)} \right]^{1/\beta} \right\}^{(1-\alpha)}$
V	$\left(\frac{\beta(1-\gamma) T}{\alpha\gamma + \beta(1-\gamma)}\right)^{\beta} \left(\frac{(1-\beta)(1-\gamma) Y}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\beta}$		$((1-\alpha\gamma)T)^{\beta} \left(\frac{(1-\beta)(1-\gamma)(1-\alpha\gamma)wT}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\beta}$		$T(1-\alpha\gamma)^{1/\beta} \left[\frac{(1-\beta)P}{(1-\beta)+\gamma(\beta-\alpha)} \right]^{(1/\beta)-1}$
$\frac{Y}{V}$	$\frac{[\alpha\gamma+\beta(1-\gamma)]^{\beta} [(1-\alpha)\gamma+(1-\beta)(1-\gamma)]^{1-\beta} Y^{\beta}}{(1-\gamma)\beta^{\beta}(1-\beta)^{1-\beta} T^{\beta}}$		$w^{\beta}\left[1+ \frac{(1-\alpha)\gamma}{(1-\beta)(1-\gamma)}\right]^{1-\beta}$		P

(20) $V = t_v^{\beta} x_v^{(1-\beta)}$

(21) $T = t_z + t_v$

(22) $Y = x_z + x_v$

The Lagrangian for this model is

$$(23)\quad \pounds = t_z^{\gamma\alpha} x_z^{\gamma(1-\alpha)} t_v^{(1-\gamma)\beta} x_v^{(1-\gamma)(1-\beta)} + \lambda_t(T - t_z - t_v) + \lambda_x(Y - x_z - x_v)$$

where $Y = Y_f$, $Y = w.t_v$, or $Y = P.V$

Table 2 reports the general solutions for each of the endogenous variables and for the unit cost of medical care. Again, the results are derived from the first order conditions for each remuneration alternative. The actual first order condition equations are reported in Appendix II.

Two immediately apparent implications are that the allocations of time between work and leisure are independent of 1) the amount of income and in some cases 2) the kind of income. In all three remuneration types, the time at work and the time at leisure have no parameters which reflect the level of income. In this Cobb-Douglas functional form model, the allocations of time are completely determined by the exponents α, β, and γ and total time T. Moreover, constant returns to scale lead to identical allocations of time between wage and output-based incomes. Decreasing returns to scale in the work production function would cause the time at work to be greatest for wage income, less for output-based income, and least for fixed income. Decreasing returns do not change the independence of the time allocations from any influence of income.

According to these mathematical solutions, a physician paid any kind of remuneration should spend a time at work which is unaffected by his or her income level. Second, physicians whose income is fixed should spend less time at work than physicians whose income is time- or output-based. Third, we have found one condition (decreasing returns to scale in the work production function) under which physicians paid a time-based income will work longer hours than under any alternative remuneration.

Physician Work and Leisure Under Three Alternative Market Dynamics

Comparisons of the remaining endogenous variables depend upon the nature of the dynamic market under which the physicians operate. We consider three extreme alternatives. The 'equal utility' assumption describes a market which would exist if physicians were sufficiently mobile between remuneration methods to force the market to adjust the 'prices' of physician services (Y, w and P) to leave physicians at an equal utility level. This market implies that purchasers bear the entire cost burden of any inefficiencies generated by suboptimal remuneration methods.

TABLE 3: Ranking of Endogenous Variables for Equal Physician Utility, Equal Physician Gross Income, and Equal Unit Cost of Medical Care

Endogenous Variable	Market Assumption	Ranking		
		Largest	Intermediate	Smallest
U physician utility	equal utility	[	EQUAL BY ASSUMPTION	]
	equal income	fixed	output-based	time-based
	equal cost	output-based	time-based	fixed
Y gross income earned	equal utility	output-based	time-based	fixed
	equal income	[	EQUAL BY ASSUMPTION	]
	equal cost	output-based	time-based	fixed
Y/V unit costs of medical care	equal utility	fixed	time-based	output-based
	equal income	fixed	time-based	output-based
	equal cost	[	EQUAL BY ASSUMPTION	]
t_z leisure time	all types	fixed	[output-based =	time-based]
t_v work time	all types	[time-based =	output-based]	fixed
x_z net income or leisure expenditures	equal utility	time-based	[fixed >,=, or <	output-based]
	equal income	[time-based =	fixed]	output-based
	equal cost	time-based	fixed[1]	
x_v practice inputs or work expenditures	equal utility	output-based	time-based	fixed
	equal income	output-based	[time-based =	fixed]
	equal cost	output-based	time-based	fixed
Z leisure activities consumed	equal utility	fixed	time-based	output-based
	equal income	fixed	time-based	output-based
	equal cost	[all ranks depend upon parameter values]		
V medical care produced	equal utility	output-based	time-based	fixed
	equal income	output-based	time-based	fixed
	equal cost	output-based	time-based	fixed

[1] Output-based income's rank depends upon the parameters. Solutions available from the authors.

The 'equal income' assumption describes a market where physicians would earn equal gross income under each remuneration method. This equilibrium could be generated by an omnipotent third-party payor who was able to adjust the remuneration rates to equalize physicians' gross incomes. We shall demonstrate that because this implies that physicians on fixed incomes do better (have higher utility levels) than their more efficient output-based income counterparts, patients of fixed income physicians face even higher relative unit costs than they face under the equal physician utility assumption.

The 'equal cost' assumption describes a market where physicians are assumed to accept a fixed unit cost level regardless of the type remuneration. This type of market implies that patients are aware of (and chose physicians on the basis of) the costs of medical care and are indifferent to how physicians are paid. In such a market, physicians absorb all costs associated with inefficient production generated by suboptimal remuneration methods.

Despite the differences between these three extreme market assumptions, the rankings of endogenous variables (Table 3) are remarkably similar. In addition to the already reported determinancy of the time allocations, the rankings of leisure activities, medical care production, and unit costs are unaffected by whether utility or gross income is assumed equal between remuneration methods. Leisure activities are greatest under a fixed income, intermediate for time-based income and least for output-based income.

Conversely, the production of medical care is greatest for output-based income, intermediate for time-based income, and least for fixed income. The per unit cost of medical care production is least for output-based income, intermediate for time-based income and greatest for fixed income.

The physician's use of practice inputs is affected by the market assumptions. Where gross incomes are equal, the physician's work expenditures are equal for time-based and fixed income. Where the physician's utility is assumed equal, practice inputs for time-based inputs are larger than those for fixed incomes.

Hypotheses Derived from the Model

Overall, we have several sets of hypotheses. Some would have been expected without any sophisticated model. Others, including a dynamic deterministic equilibrium, are less obvious. As should be expected, physicians paid on the basis of their delivery of medical care produce the most output at the least cost. Physicians paid based on their time at work spend the greater (or greatest assuming decreasing returns in V) amount of time at work relative to practice inputs, to the point of being inefficient. Physicians paid a fixed income are happiest per dollar of income and enjoy the greatest amount of leisure.

Less obvious hypotheses reported in Table 3 include the output-based remuneration as the utility and income maximizing alternative under the equal cost market assumption and the time-based remuneration as the net income maximizing remuneration under all market assumptions.

The equal utility and equal cost market assumptions result in the same deterministic dynamic equilibrium, output-based remuneration. If physicians are price takers at unit costs which are equal for all remuneration systems, they maximize their utility by selecting output-based incomes. If physicians are mobile between remuneration methods which are selected by consumers, price-conscious consumers will cost minimize by selecting an output-based remuneration method. In general, output-based incomes will always be chosen since they are superior to both fixed and time-based remunerations.

Empirically Testable Hypotheses

The transition from our three 'pure' remunerations to the real-world fee-for-service and salary alternatives is not perfectly straightfoward. For the purposes of this paper, we presume that the fees of a fee-for-service system are determined by both the physician's time and by the medical care that is produced. Similarly, we assume that salary is some mix of fixed income and time-based income.

Even though the model results we report are at the extreme forms of remuneration, our preliminary examinations with the Cobb-Douglas functions lead us to believe that mixed remunerations cause no unexpected reversals. For example in a model with all three remuneration types included in one income constraint, time spent at work increases monotonically as the proportion of total income derived from time-based rather than fixed income increases.

Our definitions of fee-for-service and salary remunerations lead us to a number of empirically observable hypotheses.

1. Salaried physicians should represent a very small proportion of the total number of physicians. We find that output-based remunerations are more efficient and are preferred under both the equal utility and the equal cost market assumptions. The equal income market characterization does not now exist.

   This hypothesis corresponds to the dynamic equilibrium for our model with remuneration type as an endogenous variable.

2. Compared with fee-for-service physicians, the salaried doctors should earn less gross income. Gross income is greatest for output-based remuneration. Furthermore, salaried physicians' gross income should be lower because they are employees and are less likely to be responsible for paying for practice inputs from their income.

3. Compared with fee-for-service physicians, the salaried doctors should work fewer hours. For all market systems, doctors with output-based incomes have a greater work time than those with fixed incomes.

4. Compared with fee-for-service physicians, the salaried doctors should have lower practice expenses. Practice inputs of the output-based

income are less than those of the fixed income under all market assumptions. Moreover as employees, salaried physicians are less likely to be responsible for paying for practice inputs from their salaried income.

5. Compared with fee-for-service physicians, the salaried doctors should produce less medical care. Work output is greatest for output-based remuneration for all three market systems.

Qualifications

Clearly, the results we have reported are not perfectly general. Nevertheless, we do have some preliminary results which support one generalization. Although the results we report in this section are derived from extreme and conceptual forms of remunerations, some preliminary work indicates that the conclusions appear to hold for a unified model with combined remuneration methods. In this model with all three remunerations in the income constraint we find that as the proportion of total income derived from time-based rather than fixed income increases, time spent at work increases monotonically.

As a first qualification, we believe that the variable rankings are sensitive to the unitary elasticity of substitution of the Cobb-Douglas function form. For example, a less than unitary elasticity of substitution between work and leisure in the utility function reverses the rank of the medical care production of time-based and fixed income. With this smaller elasticity, a physician paid a fixed income will produce more medical care than he would for the same time-based income. Alternatively, if all production and utility functions were Leontief, the three systems would produce identical results. This sensitivity to elasticities of substitution argues for some generalization of the functional forms assumed. But mathematical solutions for even the next most general function, Constant Elasticity of Substitution, would be extremely difficult. Well-developed graphical analyses appear to be the most fruitful source of generalization about alternative substitution elasticities.

Second, we have not indicated any reason other than simple X-inefficiency why any physicians should be found in any remuneration system other than output-based income. One possibility is that output-based income involves significantly greater monitoring costs. Records of medical care delivered must be collected and recorded. In situations such as teaching where that product is difficult to define and record, the otherwise suboptimal fixed income may be more efficient (especially if the degree of work-loving is high).

Another reason which may lead to other remuneration systems is the riskiness of output-based incomes. Young physicians with large debt services are especially likely to be risk averse and willing to take a certain income rather than to assume the riskiness of an output-based remuneration with a larger expected-value.

Third, our model does not address attempts by any authority to directly control practice input levels. In general, we might well expect purhcasers of physician services to intervene with controls to offset the distortions introduced under fixed income and time-based systems. Two such controls are often observed. The first is the requirement of a minimum number of hours at work. Given our assumptions, we would expect to observe minimum-time constraints with fixed-income systems, but not with time-based systems.

The second potential employer control applies to the level of the physician's practice inputs. For example, a salaried physician is likely to find his employer providing a number of practice inputs which the fee-for-service doctor would have to buy. In addition, all types of physicians may have access to hospital equipment and personnel at no marginal cost to them.

As one example of the incentive results which follow from the model, consider the comparison between fixed and time-based systems. Under the Cobb-Douglas assumptions, x_v is the same but t_v is greater for a time-based remuneration. Since an increase in t_v will raise the marginal physical product of x_v, employers of time-based physicians will have more reason to subsidize x_v. Thus while a physician's practice inputs could be subsidized under both time-based and fixed income systems, we would expect somewhat more subsidization under a time-based system, ceteris paribus.

A more thorough analysis of the effects of optimal and suboptimal practice input subsidies (hospital services are complete subsidies for selected practice inputs) will be the subject of future work. Issues will include the determinants of the size of the subsidy, the characteristics of inputs which should be subsidized, and the effects of monitoring costs.

EMPIRICAL ANALYSIS OF PHYSICIAN INCOME, PRACTICE INPUTS, AND PATIENT VISITS

The principal objective of this section is to empirically estimate the effects of remuneration method on physician income, practice inputs and medical care production. These estimates serve both as a test of the hypotheses generated by the model of the previous section and as a measure of the size of the anticipated effects. A second objective of the empirical estimates is to examine the impact of the density of physicians and hospital beds on individual physician's incomes, practice inputs and medical care production. To the extent that physicians are able to generate a demand for their services, physician density will have no effect on individual physician variables.

In the following subsections we 1) introduce the data base, 2) define the dependent and independent variables, 3) consider the hypothesized regression coefficients, 4) report the regression estimations, and 5) summarize the policy implications.

Data Base

The 1976 HCFA/NORC Survey of Physician Practice Costs and Income includes a telephone survey of 3482 office-based physicians in fifteen specialties and in solo or small group practices. The data include indications of salary, fee-for-service, expense sharing, income equalizing, and prepaid remuneration types. They also contain measures of a good variety of physician practice inputs and expenditures, physician work times, and physician-patient contacts. The original questionnaire file has been collated with the Area Resource File to incorporate socio-economic-demographic information on each physician's county of practice.

Dependent Variables

The microeconomic model of the previous section developed hypotheses about physician income (Y), practice inputs (x_v), leisure expenditures (x_z), time at work (t_v), and medical care production (V). Within the context of the HCFA/NORC Survey[7], physician income is measured by gross income (GRSINC) of Question 55. Although we recognize that gross income for fee-for-service physicians is conceptually different from that of a salaried physician, we nevertheless include a regression equation for GRSINC. The effects of the conceptual difference and of our anticipated differences from the differences between time- and output-based income both lead us to believe that gross income of the fee-for-service physician will be greater.

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[7] The original questions from the Survey instrument are reproduced as Appendix VI.

Leisure expenditures are best measured by net income (NETINC) of Question 62 in the Survey. We estimate equations for three measures of physician's time at work: patient office hours (OFFHR), hospital round hours (HSPRNDHR), and total medical hours (TOMEDHR), all from Question 27 of the Survey instrument.

We examine physician deductions from gross income (MEDDED) of Question 61 as a measure of physician practice expenditures. And we use data on the number of patient office visits (NOOFFVST) and physician hospital visits (NOHSPVST) both from Question 29 as alternative measures of the physician's medical care production.

To test the relative magnitudes of the income versus practice input and production effects, we examine each of the nonincome variable's value per $10,000 of physician's net income (NETINC).[8]

Remuneration Alternatives

The principal focus of this research is on the effects of remuneration alternatives. As we have indicated, fee-for-service and salary remunerations are not straightfoward applications of any of the conceptual pure alternatives considered in our model. For the purposes of this paper, we presume that real world fees of a fee-for-service system are determined by both the physician's time and by the medical care that is produced. Similarly, we assume that salary is some mix of fixed income and time-based income.

In the survey instrument, the list of disjoint remuneration alternatives for office-based physicians includes:

1. Salaried employee of a single doctor,
2. Salaried employee of a partnership or group,
3. Solo practice without sharing expenses,
4. Solo practice sharing expenses of one or more of office, equipment, and/or non-physician personnel,
5. Partnership not equalizing income (presumably sharing expenses),
6. Partnership equalizing income (presumably sharing expenses),
7. Unincorporated group not sharing expenses (no information on income sharing),
8. Unincorporated group sharing expenses of one or more of office, equipment, and/or non-physician personnel (no information on income sharing),
9. Incorporated group not equalizing income (presumably sharing expenses),
10. Incorporated group equalizing income (presumably sharing expenses).

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[8] See Appendix IV for a summary list of the definitions for all variables.

For all specialties and remuneration alternatives there is a question on whether the practice is prepaid, in whole, in part, or not at all. In practice, this question appears to have been interpreted as payment before services but after risk has been established.[9] Nevertheless, we include the variable PREPAID in the regressions if a physician indicated that his practice was at least partly prepaid.

Necessary Subsample

Because own (rather than the group's) gross income is reported for only salaried, solo physicians (who may share expenses), and unincorporated groups (who also may share expenses), the empirical section of this paper focuses on these remuneration types.[10] Additionally, we restricted the number of specialties to the largest six categories in order to not exhaust computer memory in our tests for interaction effects among the independent variables.

These restrictions limit the remuneration alternatives to remuneration type 1 (REMUTYPE 1) who are the salaried employees of single physicians, remuneration type 2 (REMUTYPE 2) who are the salaried employees of a small group (2 to 9) doctors, remuneration type 3 (the intercept term) who are solo fee-for-service physicians not sharing expenses, remuneration type 4 (REMUTYPE 4) who are solo fee-for-service physicians who share some expenses, remuneration type 7 (REMUTYPE 7) who are unincorporated small groups who don't share expenses, and remuneration type 8 (REMUTYPE 8) who are unincorporated small groups wo do share expenses.

These restrictions limit the specialties to general/family practice (in the intercept term), SPECIAL 6 who are general surgeons, SPECIAL 7 who are internists, SPECIAL 11 who are in Obstetrics and Gynecology, SPECIAL 15 who are pediatricians, and SPECIAL 16 who are psychiatrists.

The net effect of these restrictions is to reduce the sample from 3482 down to between 800 and 1000 physicians, depending upon the dependent variable.

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[9] See Appendix III for a description of the characteristics of the physicians who indicated that at least part of their practice was "prepaid".

[10] We include a prepaid variable in the regression equations despite apparent misunderstanding of the question by physicians. A number of obstetricians, gynecologists, and psychiatrists appear to have intepreted prepaid practice as one in which payment is made before care is delivered but after diagnosis is established.

Medical Resource Density Measures

A second focus of this research is the significance and magnitude of the effects attributable to the density of each county's principal medical resources: physicians and hospital beds. Observed correlations between health care resources and their utilization are often cited as supporting the hypothesis of supplier-induced demand. The correlation between the density of surgeons and surgery rates is especially notable [52 and 88]. Using 1966 state expenditure data, Fuchs and Kramer [32] find especially high correlations between physician supply and utilization. Similar results are obtained using data from the 1970 National Opinion Research Center study of individual health care utilization and expenditures [31 and 60] and 1969 gross billings per physician in British Columbia [25]. Despite criticisms of the econometric techniques [62], empirical support for supplier-induced demand continues to be claimed.

But no research on how supplier-induced demand affects the full range of physician production activity is apparent. The significance of Reinhardt's physician density variable in his estimated production functions [70] indicates that physician density may be expected to be important. Other research also supports the likelihood of significant effects. For example, specialists appear to be more able to create demand than primary physicians [31]. But no evidence is reported on the details of how different physicians combine their factor inputs in high versus low physician density areas.

We examine the question by including density variables on the right hand side of the income and practice input equations. BEDGHDEN measures the ratio of the number of 1976 general hospital beds to the 1976 population. MDDEN measures the ratio of the number of 1976 physicians to the 1976 population.

There are four potential interpretations of the observed physician and hospital density coefficients in our physician income and practice inputs equations. The first is based upon the presumption that the usual market laws of supply and demand are working with rapid adjustments to equilibrium. The second assumes that the adjustment mechanisms are working but with lags. The third presumes that the differences in density are attibutable to physician location preferences. The fourth suggests that physicians capitalize on their 'agent' or 'team captain' position to shift the demand for their services sufficiently to achieve some 'target income.'

If the usual mechanisms of supply and demand are adequate for rapid market adjustments (from high degrees of physician mobility) in the market for physicians services, larger numbers of physicians per capita may be interpreted as efficient responses to greater demand per capita for physician services. The existence of such a situation should be indicated by 1) the significance of demand variables such as income per capita and population density and 2) the relatively low significance of an included physician density variable in the physician income and practice input estimations.

If the market adjustment mechanisms work slowly, then changes in the demand for physician services will meet with a lagged response by physicians. If concurrently the demand for physician services was increasing the most in areas with relatively low demands in the past, then observed physician incomes would correlate negatively with existing physician density and insignificantly with the usual demand variables.

If physicians have strong preferences for the amenities of a particular region, then the markets should not be expected to adjust (physicians would not move) to equalize incomes. As long as the elasticity of demand is not infinite[11], and if physicians are unable to shift the demand for their services, physician income and practice inputs should be negatively correlated with the area's per capita income.[12]

The fourth alternative (supplier-induced demand) is one in which physicians choose their locations based on their preferences for amenities and are able to increase the demand for their services to a level where their incomes are the same regardless of the physician density. Such conditions might well be reflected by differences between the physician's ability to generate income from additional patient office and hospital visits. Indeed, our expectation is that physicians in physician-dense areas will be more able to affect the demand for their office visits than the demand for their hospital visits. One reason is that office visits require a far smaller loss of time and money. A second reason is that hospitalization may be determined largely by the physiological needs of the population. If our hypothesis is correct, we expect to find significant negative coefficients for the physician density in the hospital visits and hours equations but insignificant coefficients in office visits and hours equations.

From the perspective of a functioning market, relatively large numbers of hospital beds should increase physicians' productivity just as additional amounts of capital increase the productivity of any labor input. Clearly bed density should be significantly correlated with hospital visits and hospital round hours. If the beds increase each physician's overall productivity, then net income should also be proportional to bed density. Because a large number of hospital beds provides a substitute environment for office-based patient contacts, a substitution effect may offset the physicians increased productivity for patient

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[11] Most estimates of demand own price elasticities are significant but small [81].

[12] The coefficient of physician density in an income equation should be zero if demand price elasticty is infinite and minus one if the demand elasticity is zero.

Table 4

Descriptive Characteristics of Regression Variables

Part A: Continuous Variables

Variable	n	Mean	Standard Deviation
GRSINC	1036	7.94	4.41
NETINC	985	4.58	2.33
OFFHR	1033	28.68	11.29
HSPRNDHR	1032	8.91	7.86
TOMEDHR	1033	57.41	17.41
MEDDED	809	3.13	2.57
NOPATVST	1025	84.65	69.20
NOHSPVST	785	37.16	37.80
OFHRPNIN	983	7.92	5.42
HSHRPNIN	983	2.20	2.40
TMHRNIN	983	15.39	8.95
MDEDPNIN	798	0.73	0.58
OVSTPNIN	975	21.65	20.12
HVSTPNIN	748	8.20	7.85
BEDGHDEN	1036	0.53	0.27
MDDEN	1036	0.21	0.17
PI	1036	3.60	6.01
POPDEN	1036	0.01	0.01
POPYOP	1034	0.18	0.02
EDUCMED	1036	118.36	9.12

Part B: Discrete Variables

		Value Frequencies											
Variable	n	0	1	2	3	4	5	6	7	8	11	15	16
REMUTYPE	1033		14	29	762	179			10	39			
PREPAID	1036	1013	23										
MDAGEC	1036				201	236	319	204	76				
FMGD	1036	846	190										
FEMALED	1036	954	82										
SPECIAL1	1036						209	154	126		118	154	275

office visits. The correlations between bed density and patient office visit and between bed density and office hours cannot be signed a priori.

Other Independent Variables

Other independent variables which adjust for the physician's characteristics include his or her age and sex, possible status as a foreign medical graduate, and the previously described specialty code. We anticipate income to be lower for the young and older physicians, both because of lower wages and because of shorter work weeks. Conventional wisdom suggests that females and foreign medical graduates may earn less than indicated by their time at work and work outputs.

Independent variables which reflect the demand levels of the area surrounding the physician's practice include the county's Personal Income, percent of the population either younger than five years or older than sixty-four years, median education, and population density. Our initial maintained hypotheses are that as measures of demand, Personal Income, the percent of very young and old, and median education should be positively correlated with physician income, the use of practice inputs, and numbers of physician-patient contacts. Population density is included to control for physician's preferences of more urban areas.

We also include dummy variables for six specialties. Our microeconomic model generates no hypotheses about the effects of of specialties on any of the dependent variables. Nevertheless, the 1976 data reported by the AMA leads us to expect surgeons and Ob/Gyn physicians to have significantly higher net incomes. The AMA reports 1976 average net income of $73,245 for surgeons, $65,800 for Ob/Gyn, $60,459 for internists, $47,565 for psychiatrists, $47,438 for general practicioners, and $46,962 for pediatricians.

Variable Averages and Frequencies

Table 4 summarizes some of the key characteristic of each of the continuous and discrete variables. The principal conclusion drawn from Table 4 is that solo fee-for-service is the most frequent remuneration. The number of salaried physicians is 43. The number of solo fee-for-service doctors is 762. This results lends support to our first hypothesis, salaried physicians should represent a small proportion of total physicians.

Averages of the continuous variables in our sample of salaried, solo, and unincorporated group physicians include 1976 average gross and net incomes of $79,400 and $45,800 respectively. These physicians spent an average of 28.7 and 8.9 hours per week seeing office patients and making hospial rounds, respectively. During that time they saw 85 and 37 patients in their office and in the hospital. Overall, they worked 57.4 hours per week. The largest group of physicians were in their 50's. About 18% [(190/1036) × 100] were foreign medical graduates. And 8% [(82/1036) × 100] were women.

TABLE 5

Regression Solutions

	Dependent Variables							
Independent Variables	GRSINC	NETINC	OFFHR	HSPRNDHR	TOMEDHR	MEDDED	NOOFFVST	NOHSPVST
Intercept	11.93	5.95	41.31	10.06	51.01	5.17	252.32	88.15
	2.32^{a}	1.31^{a}	5.98^{a}	4.10^{c}	9.86^{a}	1.46^{a}	33.14^{a}	22.68^{a}
REMUTYPE 1	-3.68	-1.36	.59	4.71	13.06	-2.50	-14.92	.53
	1.07^{a}	.60^{c}	2.77	1.89^{c}	4.56^{b}	.69^{a}	15.17	10.09
REMUTYPE 2	-2.10	-.33	.55	-1.36	-4.37	-2.03	2.22	-5.46
	.75^{b}	.42	1.93	1.32	3.18	.49^{a}	10.58	6.90
REMUTYPE 4	.07	.18	-.04	-.19	-1.23	-.21	-.92	2.61
	.34	.19	.87	.59	1.43	.21	4.77	3.42
REMUTYPE 7	8.67	2.04	-3.90	2.88	3.15	4.65	17.68	24.68
	1.25^{a}	.69^{b}	3.21	2.20	5.29	.75^{a}	17.61	11.40^{c}
REMUTYPE 8	1.97	.64	2.09	1.37	2.64	.61	1.99	11.54
	.65^{b}	.37	1.68	1.15	2.76	.43	9.19	6.06
PREPAIDD	-1.59	-.58	-5.18	-1.35	-6.69	-.44	-3.04	3.95
	.83	.47	2.13^{c}	1.46	3.52	.50	11.96	8.37
MDAGEC 30's	-.27	-.16	-2.35	-.27	-1.42	-.17	-8.29	2.70
	.37	.21	.95^{c}	.65	1.56	.23	5.21	3.72
MDAGEC 40's	.44	.33	-.35	.52	1.27	.32	6.46	-.06
	.34	.19	.88	.60	1.45	.22	4.82	3.37
MDAGEC 60's	-1.42	-.70	-1.16	-.65	-3.42	-.70	-9.87	9.91
	.36^{a}	.20^{a}	.92	.63	1.51^{c}	.23^{b}	5.06	3.52^{b}
MDAGEC 70's	-3.54	-1.97	-3.19	-3.37	-11.90	-1.93	-25.77	-20.69
	.51^{a}	.29^{a}	1.32^{c}	.90^{a}	2.17^{a}	.34^{a}	7.29^{a}	5.60^{a}
FMGD	-.14	-.00	-1.61	.98	1.23	-.41	-10.76	-4.44
	.33	.19	.86	.59	1.42	.22	4.74^{c}	3.23
FEMALED	-2.22	-1.44	-.53	-1.32	-3.41	-.55	-14.37	-9.78
	.47^{a}	.27^{a}	1.21	.83	2.00	.34	6.70^{c}	4.90^{c}
SPECIAL 6	1.12	.94	-13.43	3.93	1.48	-.20	-71.41	19.99
	.42^{b}	.24^{a}	1.09^{a}	.75^{a}	1.79	.27	5.98^{a}	3.99^{a}
SPECIAL 7	.19	.19	-3.57	4.51	.14	-.54	-48.01	5.70
	.45	.26	1.17^{b}	.80^{a}	1.93	.29	6.46^{a}	4.26
SPECIAL 11	1.08	.62	-7.92	-.35	-3.22	.42	-51.06	-8.83
	.46^{c}	.27^{c}	1.19^{a}	.82	1.97	.30	6.56^{a}	4.34^{c}
SPECIAL 15	-.32	-.18	3.49	-1.42	-1.86	-.35	4.68	-11.49
	.44	.25	1.14^{b}	.78	1.88	.28	6.28	4.23^{b}
SPECIAL 16	-1.57	.09	-2.07	-4.01	-9.28	-2.13	-86.84	-16.36
	.41^{a}	.23	1.05^{c}	.72^{a}	1.73^{a}	.26^{a}	5.77^{a}	4.39^{a}
BEDDEN	1.55	.72	-.43	3.89	3.16	1.40	11.74	18.83
	.58^{b}	.33^{c}	1.49	1.02^{a}	2.46	.36^{a}	8.21	5.68^{a}
MDDEN	-2.07	-.99	-5.14	-9.23	-9.77	-1.23	-25.85	-35.38
	1.26	.73	3.25	2.22^{a}	5.35	.83	17.86	12.65^{b}
PI	.01	.39	-3.52	-4.73	-23.46	1.36	-52.67	-16.34
	.02	1.21	5.52	3.79	9.10^{c}	1.34	30.31	22.26
POPDEN	-28.87	-17.77	56.57	-13.87	48.53	-12.84	-306.43	-212.70
	14.49^{c}	8.31^{c}	37.38	25.62	61.59	9.34	206.45	167.90
POPYOP	2.08	-.23	-19.51	-.87	5.60	-.32	87.47	69.86
	5.72	3.26	14.79	10.14	24.37	3.53	81.48	56.11
EDUCMED	-.03	-.01	-.03	-.00	.09	-.01	-1.09	-.52
	.01	.01	.04	.03	.06	.01	.22^{a}	.15^{a}
R^2	.23	.16	.23	.25	.12	.27	.39	.22
F	12.89^{a}	8.09^{a}	13.03^{a}	14.55^{a}	6.13^{a}	12.49^{a}	27.13^{a}	9.54^{a}
Observations	1031	981	1028	1027	1028	805	1020	780

NOTES: Regression Coefficients are reported over their Standard Errors.
a indicates significance at the .001 level
b indicates significance at the .01 level
c indicates significance at the .05 level
All the Regression Variables are defined in Appendix IV

TABLE 6

Regression Solutions
(Dependent Variables per $10,000 of Net Income)

Independent Variables	OFFHR/INC	HSPHR/INC	TOMEDHR/INC	MFDDED/INC	OFFVST/INC	HSPVST/INC
Intercept	11.29	1.69	12.85	.78	65.20	16.25
	2.95^{a}	1.33	5.10^{c}	.35^{c}	10.40^{a}	5.01^{b}
REMUTYPE 1	4.05	3.92	12.11	-.33	6.54	5.46
	1.35^{b}	.61^{a}	2.33^{a}	.16^{c}	4.70	2.20^{c}
REMUTYPE 2	-.17	-.33	-1.64	-.52	1.05	-.92
	.95	.43	1.65	.12^{a}	3.33	1.53
REMUTYPE 4	-.41	-.07	-.83	-.06	-1.28	-.14
	.43	.20	.75	.05	1.51	.77
REMUTYPE 7	-2.72	-.44	-2.98	.65	-2.08	-.18
	1.56	.71	2.70	.18^{a}	5.45	2.49
REMUTYPE 8	.20	.27	-.15	.11	-.20	1.49
	.84	.38	1.45	.10	2.92	1.34
PREPAIDD	.25	.26	1.18	.06	6.41	2.63
	1.06	.48	1.84	.12	3.79	1.89
MDAGEC 30's	-.53	-.22	-.17	-.03	-2.24	1.11
	.47	.21	.81	.06	1.65	.83
MDAGEC 40's	-.84	-.11	-1.24	.02	-.61	-.93
	.44	.20	.76	.05	1.53	.75
MDAGEC 60's	.59	.03	.85	-.08	.04	-.97
	.46	.21	.79	.05	1.60	.78
MDAGEC 70's	3.29	-.31	3.96	-.18	.37	-2.58
	.66^{a}	.30	1.15^{a}	.08^{c}	2.34	1.25^{c}
FMGD	-.74	.44	.16	-.11	-3.08	-.71
	.43	.19^{c}	.74	.05^{c}	1.51^{c}	.72
FEMALED	4.04	.51	6.63	.18	6.90	1.06
	.61^{a}	.28	1.06^{a}	.08^{c}	2.15^{b}	1.10
SPECIAL 6	-4.15	.72	-2.06	-.15	-20.88	2.01
	.54^{a}	.24^{b}	.94^{c}	.07^{c}	1.89^{a}	.88^{c}
SPECIAL 7	-.80	1.35	.61	-.18	-11.60	1.43
	.58	.26^{a}	1.01	.07^{c}	2.04^{a}	.95
SPECIAL 11	-2.52	-.08	-1.55	.02	-15.34	-2.21
	-.60^{a}	.27	1.04	.07	2.09^{a}	.97^{c}
SPECIAL 15	1.26	.16	.15	.05	.71	-2.35
	.57^{c}	.26	.98	.07	1.98	.93^{c}
SPECIAL 16	-1.02	.97	-3.06	-.50	-22.30	-4.02
	.52^{c}	.23^{a}	.90^{a}	.06^{a}	1.82^{a}	.97^{a}
BEDDEN	-1.45	.72	-2.07	.16	-.19	3.16
	.74	.33^{c}	1.28	.09	2.59	1.27^{c}
MDDEN	.42	-2.76	.76	-.09	-1.85	-7.87
	1.65	.75^{a}	2.86	.20	5.79	2.93^{b}
PI	-3.91	-.92	-10.28	.19	-21.20	-7.12
	2.72	1.23	4.71^{c}	.32	9.50^{c}	4.90
POPDEN	62.74	12.41	93.74	-.63	16.30	11.94
	18.76^{a}	8.48	32.43^{b}	2.27	65.90	38.06
POP70YOP	-7.73	-1.24	-2.35	-.39	-.31	7.69
	7.37	3.33	12.73	.85	25.81	12.45
EDUCMED	-.00	.01	.04	.00	-.25	-.07
	.02	.01	.03	.00	.07^{a}	.03^{c}
R^2	.21	.18	.14	.18	.31	.15
F	11.23^{a}	9.21^{a}	6.67^{a}	7.53^{a}	18.18^{a}	5.54^{a}
Observations	979	979	979	795	971	744

NOTES: Regression Coefficients are reported over their Standard Errors.
All the Regression Variables are defined in Appendix IV.
a indicates significance at the .001 level b indicates significance at the .01 level
c indicates significance at the .05 level

Empirical Estimates

The regressions reported in Table 5 estimate the effects of remuneration types and other relevant variables on the means of physician incomes, practice inputs, and production. The regressions of Table 6 report the effects of the same variables on physician practice inputs and production per $10,000 net income. In every equation, the intercept is the estimated value for 50 to 59 year old male, solo fee-for-service, general (or family) physicians who do not share expenses and who were educated in the United States. In the following paragraphs we discuss the significance of salaried and fee-for-service remunerations, medical resource densities, physcians' sex, age, and foreign medical graduate status~[13]

Remuneration Alternatives

There are a number of significant differences between the solo fee-for-service physician and doctors who are salaried employees of single doctors. The salaried physicians employed by a single doctor earn $36,800 and $13,600 less gross and net income. These results are derived from the coefficients -3.68 and -1.36, row 1, columns 1 and 2 of Table 5. REMUTYPE 1 is salaried employees of single physicians. GRSINC and NETINC are gross and net incomes reported in $10,000.

They spend 4.7 more hours per week on hospital rounds and 13.1 more hours in all aspects of medical care. They do not produce significantly different numbers of patient office or hospital visits. Per $10,000 of net income (Table 6), they work 4.0 more office hours, 3.9 more hospital hours, and 12.1 total medical hours and produce 5.5 more hospital visits per week. And their lower medical deductions confirm the expected lower levels of practice expenditures.

These results are not entirely anticipated by our model. Although our expected lower gross incomes and lower practice expenditures are confirmed, salaried physicians of single doctors work longer hours and produce more medical care than the fee-for-service counterparts. We expected them to work fewer hours and produce less. Interestingly, these unanticipated results are not duplicated by salaried physicians employed by a group of physicians. The group-salaried again earn less gross income and utilize less practice inputs than the fee-for-service doctors but are not significantly different from the fee-for-service doctors in their hours worked and medical produced.

One explanation for the unanticipated results and importance of the number of employing physicians is that the remuneration type 1's are young doctors who are on trial as potential partners in already established practices.

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[13] A table of results without variables for the medical resource densities or the county's Personal Income, education or very young and old population is included as Appendix V for comparative purposes.

Although this hypothesis is supported by our discussions with physician friends and relatives, it is not supported by our (unreported) interaction regressions in which the interaction or dummy variable for young salaried physicians is not significant.

There are no significant differences between fee-for-service solo practices that do and that do not share some expenses.

The unincorporated group physicians that do not share expenses earn $86,700 more gross and $20,400 more net income, have greater medical deductions, and make almost 25 more hospital visits per week than the solo fee-for service doctors used as the basis of comparison.

Supplier-Induced Demand

Although the coefficients of physician density are negative in both the gross and the net income equations, neither coefficient is significant. The implication is that greater physician density does not significantly reduce either physician gross or net income. This evidence leaves us unable to reject the hypothesis that physicians are able to generate their incomes regardless of the number of physicians in the region. Moreover, since we have controlled for the most obvious demand determinants in each area, we can further conclude that this ability to generate income is not obviously demand related.

As predicted by the hypothesis that hospital beds are a factor input which increase physician productivity, bed density positively correlates with gross income, net income, hospital round hours, and the number of hospital visits. The positive coefficients in the hospital-hours-per-dollar-of-net-income and the hospital-visits-per-dollar-of-net-income equations suggest lower hospital income per hour and per service unit.

Female Physicians

The female dummy variable generated a surprisingly strong series of coefficients. After controlling for all the variables in the equations, female doctors earn $22,200 less gross income and $14,400 less net income than their male counterparts. This difference appears to be determined by 14 fewer office and 10 less hospital visits, but not by fewer office, hospital or total medical hours. Per dollar of net income, female physicians work longer office and total medical hours and see significantly more office patients (without seeing fewer hospital patients).

Age

Physicians over sixty earn less income, work fewer hours, and see fewer patients in both the office and hospital. Two significant coefficients indicate that physicians over seventy spend a larger number of office and total medical hours per dollar of income.

Foreign Medical Graduates

Foreign medical graduates are only observed to see fewer patients in the office, to spend more time in the hospital per dollar of net income, and to see fewer office patients per dollar of net income.

Miscellaneous

Two miscellaneous results run against the hypothesis of a fully equilibriated market. As indicators of demand, Personal Income, population density, and education should be positively correlated with physicians' income and medical production. But we observe a) that population densities correlate with lower physician gross and net incomes and b) that Personal Income correlates negatively with total medical hours. The implication is for either 1) a market in which physicians' preferences for more populated, more dense, higher income areas do affect their practice characteristics or 2) a dynamic market in which high demand characteristics are indicators for low changes in demand.

Finally, we observe higher median education levels correlate with lower number of both office and hospital visits. This is consistent with hypotheses that educated individuals are more healthy and need less medical care.

Qualifications

As in any empirical analysis, we may have generated biased coefficients to the extent that the regression equations omit or misspecify any causal variable. Clearly, the regressions do not estimate the behavioral equations of a economic model. Such a series of equations such include price variables and should estimate remuneration type as a right-hand dependent variable. Rather, our equations are the reduced form equations which have been suggested by the solutions to the microeconomic model of the previous section. In this context, we have included all those variables which we hypothesize to be relevant and need not use simultaneous equation techniques to estimate the effects of remuneration type.

PRODUCTION FUNCTION ESTIMATIONS

Remuneration alternatives are prices which may be expected to affect economic, but not technological, efficiencies. Nevertheless, production function estimates remain as a source of insight into the nature of supply-induced demand. As anticipated in the contract, we have focused our attention on the Cobb-Douglas function form; even the simplest translog equations are subject to severe multicollinearity. In the paragraphs below we compare our measures of medical care production with the existing literature, introduce the remuneration alternatives, and describe other variables which serve to change or shift the entire production function.

Background[14]

Issues which are identified and considered in estimating physician production functions include selection of the algebraic form of the production function and of the measures of physician outputs, practice inputs, and variables which shift the production function intercept. Possible econometric problems include multicollinearity from too little variation in factor proportions, biased coefficients from too much technical inefficiency, and biased coefficients from simultaneously determined production inputs.

Our responses to these issues include 1) specification of a modified Cobb-Douglas functional form which allows some nonessential inputs to have negative productivities; 2) examination of office visits as outputs; and 3) utilization of physicians' weekly office hours, physicians' expenditures on space, medical equipment, and medical supplies, and nonphysician hours as productive inputs. Nonproductive variables included in the equations as factors affecting the intercept term include the physician's age and specialty and the area's physician density.

Others have used specifications not entirely dissimilar. Using data from 1965 and 1967 Medical Economics surveys of physicians [70], Reinhardt finds physician hours to be the most important determinant of output. Kimbell and Lorant [53] obtain similar results using the American Medical Association's Seventh Period Survey of Physicians and Survey of Medical Groups in 1971. Perhaps because Kimbell and Lorant are able to measure capital by examination rooms rather than by outlays they alone find that capital contributes significantly to physician's output.

Indexes of the Physician's Medical Care Production

Conceptually, physicians' production of medical care should be measured by improvements in their patients' health. Unfortunately, no such measures exist in an operational form. Moreover, they are not likely to be generated in the near future. They may even be conceptually impossible [16, p. 654]. In the absence of measures of changes in patients' health, researchers have utilized several alternative proxies for health care production. Kimbell and Lorant use practice gross revenues which is equivalent to weighting patient contacts by the price charged for each. Reinhardt has suggested either selecting the number of the single most frequent type of contact or adding all contacts into a single sum (i.e. assigning equal weights to all). Additional alternatives cited by Sorkin [81] include weighting the contacts by relative cost or by physician's time. This research has been successful in considering each of the components of medical care outputs separately. In particular, we report production function estimates using the number of office visits.

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[14] This section draws heavily from Reinhardt [70].

Extensions of these initial results using additional output measures, weighted combinations of output measures, and a more controversial alternative, Joreskog's maximum likelihood confirmatory factor analysis [50], remain for later research.

Production Inputs

Production inputs include the physician's hours at patient care and nonpatient care, office personnel hours, the utilization of certain procedures, and expenditures on office space and utilities, on medical equipment, and on medical materials and supplies. The physician's own time with patients is measured by questions 26 and 27. Physician administrative time is measured by question 25. Physician-employee hours are measured by question 48B. Other office personnel hours are measured by questions 53 and 54. Question 35 provides a proxy for the use of diagnostic, office, and referral procedures for specialty group A. Questions 42.1 to 42.3 measure the practice's use of office space, medical equipment, and medical supplies.[15]

A fundamental problem with this group of questions is that some apply to the individual physician while others apply to the aggregation of physicians. For example, the physician's hours with patients and with administrative duties are his own. But the hours of employee-physicians and office personnel and the expenditures on office equipment, and supplies all apply to the aggregation of physicians if there is a partnership or a group. Kimbell and Lorant's resolution was to use the group's gross revenue as the dependent variable.

Our approach is to limit the study to those physicians in solo practice or unincorporated groups who report their own income and expenses directly. This reduces the sample from 3482 to approximately 1000 physicians.

Shift and Adjuster Variables

The variables so far described have been "essential" inputs [70]. A second group of variables which serve to shift or adjust the production function

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[15] See Appendix VI for the questions from the Survey Instrument.

Table 7

Production Function Characteristics

Function Name	Function Form	Estimated Form	Homogeneous Degree One	Homogeneous Constant Degree	Homogeneous	Homothetic	Quasi-concave	$\sigma=1$	$\sigma_{12}=\sigma_{23}$	Constant σ	Multiple Outputs
Cobb-Douglas	$Y = A\, X_1^{\alpha_1} X_2^{\alpha_2} X_3^{\alpha_3}$	$\ln Y = A + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CES	$Y=[\sigma_1 X_1^{-\beta}+\sigma_2 X_2^{-\beta}+\sigma_3 X_3^{-\beta}]^{-h/\beta}$	$\ln Y = A + h\sum_i \delta_i \ln X_i - \frac{1}{2}h\beta\sum\sum_{ij} \delta_i \delta_i (\ln X_i - \ln X_j)^2$ $\Sigma\sigma_i = 1$	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
VES			No	Yes	Yes?	Yes?	Yes	No	No	No	Yes?
Transcendental	$Y = \prod_i X_i^{\alpha_i} e^{\Sigma\alpha_i' X_i}$	$\ln Y = A + \sum_i \alpha_i \ln X_i + \sum_i \alpha_i' X_i$	No	Yes	No	Yes	Yes	No	?	No	?
Trans-Log		$\ln Y = A + \sum_i \alpha_i \ln X_i + \frac{1}{2}\sum\sum_{ij} \gamma_{ij} \ln X_i \ln X_j$	No	Yes	NO	No	Yes	No	No	?	Yes
Generalized Leontief	$Y=h\,(\sum\sum_{ij} a_{ij} X_i^{\frac{1}{2}} X_j^{\frac{1}{2}})$	Same	No	No	?	No?	No	No	No	No	?

intercept are the characteristics of the county, especially the densities of medical resources. Of particular interest on the 1976 File are 1) the number of 1976 physicians divided by the 1976 population estimate and 2) the number of 1975 short-term general hospital beds (1976 data not available) divided by the 1975 population estimate. Other county characteristics which will be examined are the population density, the 1974 per capita income, the median school years completed, and the proportion of old and young people. The physician's age, sex, specialty and education define an additional set of variables which may be expected to affect the production function estimates.

Production Function Form

Potential forms of production functions include the Cobb-Douglas, the Constant Elasticity of Substitution (CES), the Variable Elasticity of Substitution (VES), the transcendental logarithmic (trans-log) and the Generalized Leontief (GL). Roughly, the progression from the beginning to the end of the list increases the information, increases the number of parameters which must be estimated, and reduces the restrictive assumptions implicitly made (Table 7). For example, the Cobb-Douglas function tests for nonconstant returns to scale, but assumes an unitary elasticity of substitution between all inputs regardless of scale. At the other extreme, the trans-log functions and generalized Leontief functions test for returns to scale and for elasticities of substitution values for each different inputs.

Intriligator [49, p. 269] points out that estimates of production functions typically are subject to econometric problems of simultaneity, multicollinearity, and heteroskedasticity. In anticipation of these problems this research estimates the simplest Cobb-Douglas. Translog equations are to be reported to the extent that the data support their estimation.

Hypothesis Testing

There are several groups of tested hypotheses. These include statements about the productivity of each factor input and the impact of high medical resource densities on both groups of hypotheses. They also include the assumption that physicians have considerable flexibility in combining their own time with other practice inputs. This flexibility should also be demonstrated by a nondestructive level of multicollinearity in production function estimations.

For the remuneration and resource density questions, two types of significance tests are employed: tests on variable coefficients and tests of significant differences between the estimations on different observations groups. The choice among these two methods depends upon the nature of the relevant variables and the number of observations in the cells of parameters being examined. When the adjuster variables are cardinal, their influence is monotonic, and they have a large number of observations, their effect may be best tested by their significance in the regression estimations. When the variables are not cardinal and there are small numbers of variable values each with large number of observations, analyses of variances are more appropriate.

TABLE 8

Initial Production Function Estimates
All Office Based Physicians
[The Dependent Variable is the log of Patient Office Visits]

			Expenditures				
Specialty	Intercept	Patient Office Hours	Space	Medical Equipment	Medical Supplies	Non-MD Personnel	R^2 n
All	1.11	.81	-.03	-.01	.10	.23	$.47^a$
	5.46^a	26.41^a	11.58	-.56	8.38^a	8.39^a	1476
01 Allergy	-.94	1.12	.25	.01	-.02	-.37	$.42^a$
	-.76	5.41^a	2.02^c	.17	-.20	-1.99	55
02 Cardiovascular	1.69	.84	-.09	-.06	.07	.49	$.65^a$
	1.88	5.66^a	-.91	.83	1.07	2.97^b	53
03 Dermatology	3.27	.77	-.18	.03	.03	.25	$.35^a$
	2.49^c	3.56^b	-1.47	.57	.51	2.34^c	63
04 Gastroenterology	2.33	.89	-.15	.03	-.05	.33	$.55^a$
	1.69	5.17^a	-1.04	.54	-.54	2.01	44
05 General/Family	2.00	.78	-.10	.04	.06	.22	.36
	3.67^b	6.68^a	-2.12^c	1.61	1.71	3.08^b	173
06 General Surgery	1.32	.61	.01	.01	.10	.15	$.34^a$
	1.88	6.42^a	.15	.17	2.60^b	1.73	166
07 Internal Medicine	1.39	.78	-.02	-.001	.04	.23	$.37^a$
	2.43^c	6.77^a	-.33	-.05	1.08	3.15^b	137
08 Neurological Surgery	-.32	.71	.18	.04	-.02	.12	$.42^a$
	.82	4.13^a	1.01	.67	-.31	.68	54
11 Obstetrics-Gynecology	1.88	.71	.03	.02	.06	.28	$.39^a$
	2.44^c	8.45^a	.59	.81	2.24^c	4.20^a	205
12 Ophthalmology	2.51	.57	-.04	.02	.01	.33	$.43^a$
	4.22^a	5.42^a	-.82	.89	.48	5.09^a	92
13 Orthopedic Surgery	2.45	.33	.02	-.04	.13	.04	.15
	2.56^c	2.11^c	.24	-.99	2.04^c	-.34	61
14 Otolaryngology	3.07	.47	-.12	.07	.05	.18	$.25^b$
	3.82^b	3.20^b	-1.67	1.89	1.09	1.72	84
15 Pediatrics/ Pediatric Surgery	1.55	.71	.01	-.03	.10	.04	$.21^a$
	2.23^c	5.21^a	.28	-.91	2.29^c	.47	161
16 Psychiatry	.90	.997	-.15	-.04	.14	.16	$.64^a$
	1.07	7.41^a	2.16^c	-.89	3.34^b	1.79	57
17 Urology	1.13	.48	.10	.02	.04	.35	.42
	1.36	3.59^b	1.27	.29	.70	2.68^b	70

NOTES: [a]Significant at the .0001 level [b]Significant at the .01 level [c]Significant at the .05 level
Regression coefficients are reported over their Standard Errors.

In the paragraphs below we report 1) Cobb-Douglas equations for all office-based physician specialties which were derived early in the research, 2) Cobb-Douglas equations for the six major Specialties which focus attention on the importance of physician density, and 3) a selected number of translog equations which illustrate both multicollinearity and results parallel to the Cobb-Douglas equations.

Preliminary Cobb-Douglas Functions

This section discusses some of the initial production function estimations for office-based physician specialties using a straightfoward Cobb-Douglas Production Function,

$$(24) \quad V = A t_v^{\alpha} x_{v1}^{\beta} x_{v2}^{\gamma} x_{v3}^{\delta} x_{v4}^{\zeta}$$

where A is a constant,

t_v is own time at work measured as patient office hours,

x_{v1} is expenditures on office space and utilities,

x_{v2} is expenditures on medical equipment,

x_{v3} is expenditures on medical materials and supplies,

x_{v4} is the number of non-physician employees, and

α, β, γ, δ, and ζ are parameters

The results for all physicians considered together and by specialty (Table 8) indicate that the physician's own time is consistently the most significant production factor with the largest output elasticity. Other less significant practice inputs include expenditures on materials and supplies and the number of non-physician employees. Expenditures on medical equipment are insignificant everywhere. Expenditures on office space and utilities are insignificant in most specialties but do appear with negative coefficients for General/Family Practices and for Psychiatry.

The results are not entirely dissimilar to those of Reinhardt and Kimbell and Lorant. For example, our own time (and non-physician time) parameters are somewhat larger than (and roughly equivalent to) Reinhardt's while our negative coefficients for space costs contrast with his smaller (and Kimbell and Lorant's larger) effect of capital.

Production Functions and Supplier-Induced Demand

Our more recent production function estimates have been designed to investigate the importance of medical resource densities for potential insights into supplier-induced demand. In order to facilitate comparisons between these equations and the equations of physician income and practice inputs, we have again limited the observations to physicians not in incorporated groups and in the largest six specialties (General/Family, General Surgery, Internal Medicine, Ob/Gyn, Pediatrics, and Psychiatry).

TABLE 9
Cobb-Douglas Production Function Estimates
(Dependent Variable = Number of Office Visits)

INDEP. VARIABLE	EQUATION 1	2	3	4	5	6	7	8	9	10	11	12	13
INTERCEPT	.56 .21^{b}	.66 .20^{b}	.64 .21^{b}	1.06 .29^{a}	.54 .81	.18 .44	1.16 .20^{a}	1.00 .47^{c}	.51 .62	.73 .75	.96 .69	.58 .82	.18 .31
PATOFFHR	.86 .04^{a}	.88 .04^{a}	.88 .04^{a}	.78 .06^{a}	.95 .08^{a}	.97 .09^{a}	.90 .04^{a}	.92 .11^{a}	.68 .08^{a}	.81 .15^{a}	.72 .16^{a}	1.08 .20^{a}	.99 .07^{a}
OTHMDHR	.06 .03^{c}	.05 .03^{c}	.06 .03^{c}	.05 .03	-.01 .05	.10 .06	.05 .02^{c}	.06 .05	.17 .09	.01 .10	.11 .10	.14 .08	.03 .03
SUPLYCST	.10 .01^{a}	.09 .01^{a}	.09 .01^{a}	.11 .01^{a}	.09 .02^{a}	.06 .01^{a}	.03 .01^{a}	.07 .03^{c}	.13 .03^{a}	.12 .05^{c}	.06 .04	.02 .04	.01 .01
OFSPCCST	-.04 .01^{b}	-.04 .01^{b}	-.04 .01^{b}	-.03 .02	-.04 .03	-.02 .02	-.02 .01	-.02 .03	-.03 .06	-.05 .05	-.01 .03	-.03 .04	-.01 .02
MEDEQCST	.01 .01	.01 .01	.01 .01^{c}	.01 .01	.01 .01	.02 .01	.01 .01^{c}	.02 .01	-.00 .01	.02 .01	.00 .02	.01 .02	.01 .01
NONMDHRS	.12 .01^{a}	.11 .01^{a}		.07 .01^{a}	.14 .03^{a}	.12 .03^{a}	.06 .01^{a}	.05 .02^{c}	.08 .02^{a}	.06 .03	.09 .03^{c}	.03 .03	.01 .05
MDDEN		-.73 .14^{a}	-.76 .15^{a}	-2.78 .59^{a}	-.49 3.28	-.35 .28	-.50 .13^{a}	-.48 .52	-.97 .47^{c}	-.47 .40	-1.23 .63	-.84 .46	-.18 .18
BEDGHDEN		.12 .09	.11 .09	.14 .11	.09 .28	-.04 .16	.12 .08	-.05 .16	.36 .21	.33 .26	.40 .34	-.06 .26	-.03 .13
FEMALED		-.03 .07	-.04 .07	-.03 .11	.01 .13	.02 .12	-.05 .07	-.55 .40	.35 .46	-.02 .29	-.02 .23	.01 .13	-.06 .09
FMGD		.09 .05	.07 .05	.06 .07	.09 .11	.16 .10	.03 .05	-.15 .12	-.11 .13	.14 .14	.20 .15	.10 .12	.02 .08
RNHRS			.08 .01^{a}										
LPNHRS			.08 .01^{a}										
TECHHRS			.06 .02^{a}										
PANPHRS			.00 .02										
REMUTYPE 4							.02 .04						
7							.35 .16^{c}						
8							.00 .09						
SPECIAL1 6							-.25 .07^{a}						
7							-.35 .06^{a}						
11							-.29 .06^{a}						
15							-.08 .06						
16							-.80 .07^{a}						
R^2	.60	.61	.60	.58	.67	.57	.67	.47	.65	.37	.47	.29	.50
F	208	133	98	62	33	26	95	14	19	5	7	4	24
Observat.	851	851		466	178	207	848	170	116	99	92	117	257
See Note				1	2	3		4	5	6	7	8	9

NOTES:
1. Sample limited to physicians in counties with physician density less than its median.
2. Sample limited to physicians in counties with physician density greater than its median but < the mean.
3. Sample limited to physicians in counties with physician density greater than its mean.
4. Sample limited to Speciality 5, General/Family Physicians.
5. Sample limited to Speciality 6, General Surgery.
6. Sample limited to Speciality 7, Internal Medicine.
7. Sample limited to Speciality 11, Obstetrics/Gynecology.
8. Sample limited to Speciality 15, Pediatrics/Pediatric Surgery.
9. Sample limited to Speciality 16, Psychiatry/Child Psychiatry.

These equations take the estimated form

$$(25)\quad V = b_0 + b_1 t_{v_1} + b_2 t_{v_2} + b_3 x_{v_1} + b_4 x_{v_2} + b_5 x_{v_3} + b_6 x_{v_4} + b_7 X_1 + b_8 X_2 + b_9 X_3 + b_{10} X_4$$

where t_{v_1} is own time in direct work production, measured as the log of patient office hours,

t_{v_2} is own time at work in other than patient office hours, measured as the log of (total work hours minus office hours),

x_{v_1} is the log of expenditures on medical materials and supplies,

x_{v_2} is the log of expenditures on office space and equipment,

x_{v_3} is the log of expenditures on medical equipment,

x_{v_4} is the log of the combined hours of registered nurses, licensed practical nurses, medical technicians, physician extenders and nurse practitioners,

X_i are all shift and adjuster variables which include

X_1 the number of physicians per capita in the county,

X_2 the number of general hospital beds per capita in the county,

X_3 a dummy variable set equal to one for female physicians, and

X_4 a dummy variable set equal to one if the physician was trained outside the United States.

The most obvious conclusion to be drawn from the regression results (Table 9) confirm the earlier results that patient office hours are the major factor contributing to the production of office visits. For example, in Equation 1 the largest and most significant coefficient (b_1=.86) indicates that for every 10% increase in a physician's patient office hours, the number of patients seen will increase by 8.6%. In the same initial equation, the next most productive factor is the hours of non-physician (medical) personnel in the physician's office (b_6=.12). It is followed by expenditure on supplies and materials (b_3=.10) and the physician's non-office hour work time (b_2=.06).

The addition of the physician and hospital bed density and other adjuster variables (Table 9, Equation 2) to the initial basic equation increases the R^2 slightly, but lowers the F statistic. Each of the factor productivities remain the same; only one of the adjuster variables, physician density, is significant.

In order to identify which of the non-physician medical personnel are the most productive, we divided the NONMDHRS variable into four components, the hours of registered nurses (RNHRS), licensed practical nurse hours (LPNHRS), technician hours (TECHHRS), and physician assistant and nurse practitioner hours (PANPHRS). Unfortunately there are no observations for physicians who employee all four types of assistance. Therefore our SAS GLM Procedure would not run the regressions for lack of observations.

Because of the potential interest in the relative productivities of the four non-physician groups, we forced an illegal transformation, log(0)=0, to generate observations. The results (Table 9, Equation 3) are startling enough to report. The contribution of RN's, LPN's, and technicians are all comparable and highly significant. However the physician assistants and nurse practitioners do not appear to significantly contribute to the production of office visits. Although our illegal transformation makes the results very weak in the sense that they can not survive any rigorous criticism, they do raise a policy question about the practicality of the government's pushing physician assistants rather than the currently available (and apparently more productive) nurse and technician alternatives.

In order to better understand the effects of physician density, we divided the physician observations into three groups: those in counties with physician densities less than the median[16] (Table 9, Equation 4), those in couties with physician densities between the median and the mean (Table 9, Equation 5), and those in counties with densities greater than the mean (Table 9, Equation 6).

Several observations follow from the estimates of Cobb-Douglas output elasticities. First, the output elasticities of patient office hours, expenditures on materials and supplies, and non-physician medical personnel are significant factors in all three equations. Second, the output elasticities of patient office hours and of non-physician medical personnel are greater in the high physician density counties. Third, the output elasticity of materials and supplies is greater in the physician sparce areas. Fourth, the returns to scale are slightly less than one (.781 + .111 + .073 = .965) for the sparce counties and slightly greater than one (.969 + .056 + .123 = 1.145) for the dense counties.

These results are consistent with several hypotheses. First, if the demand for physicians in the sparce areas is relatively great compared with the number of physicians, then we should expect to observe doctors using relatively less of their own time and more supplies and materials per office visit. In fact, the implied factor share of PATOFFHR is .81 (.78/.96) in the low density areas and .85 (.97/1.14) in the dense areas. At the same time, the factor share of SUPLYCST is .11 and .05 in the low and high density areas. Doctors in less physician-dense areas who may be pressed by relatively high demands for their services appear to substitute materials and supplies such as drugs, biologicals and X-rays for their own time.

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[16] The median value of MDDEN is 0.191. The mean value of MDDEN is 0.226.

TABLE 10

Translog Production Function Estimates
The Dependent Variable is the Number of Office Visits

	Equation			
	1	2	3	4
INTERCEPT	.46	.12	.82	1.04
	.31	.47	.99	.53
PATOFFHR	.91	1.08	.81	.24
	.09^a	.14^a	.19^a	.15^a
	.19	.15	.17	.27
SUPLYCST	.14	.31	-.03	.03
	.05^b	.07^a	.11	.09
	.01	.02	.01	.01
NONMDHRS	.05	-.05	.45	-.26
	.08	.11	.17^c	.27
	.01	.01	.01	.01
PATOFFHR × SUPLYCST	-.01	-.06	.03	.01
	.02	.02^b	.03	.03
	.01	.01	.01	.01
PATOFFHR × NONMDHRS	.02	.04	-.06	.13
	.02	.03	.05	.06^c
	.01	.01	.01	.01
SUPLYCST × NONMDHRS	.00	.00	-.01	-.01
	.00	.01	.01	.03
	.05	.07	.03	.01
MDDEN	-.58	-2.99	-.99	-.28
	.11	.56^a	3.25	.17
	.86	.93	.97	.90
R^2	.59	.57	.66	.55
F	181	91	48	37
Observations	880	481	181	218
See Note Number		1	2	3

NOTES:

Regression Coefficients are reported over their Standard Errors and Tolerances [63, p. 346] respectively.

1. Observations limited to those with MDDEN less than its median.
2. Observations limited to those with MDDEN between the median and mean values.
3. Observations limited to those with MDDEN greater than its mean.

a indicates significance at the .001 level.
b indicates significance at the .01 level.
c indicates significance at the .05 level.

To test for the possibility that the production functions were essentially different for each specialty and for each remuneration, we estimated an equation with REMUTYPE and SPECIAL1 as independent variables (Table 9, Equation 7). REMUTYPE 7, physicians in unincorporated groups who are paid on a fee-for-service basis, is marginally significant. No additional equations were estimated because no practice input data are recorded for salaried physicians.

Because the five specialty types were highly significant, we estimated production functions for each specialty. Equations 8 to 13 reconfirm the importance of the physician's office hours as the principal determinant of the number of patient office visit for every specialty. Expenditures on materials and supplies (SUPLYCST) are significant in the GP/FP, General Surgeon, and Internal Medicine equations. The hours of non-physician medical personnel (NONMDHRS) are significant for GP/FP, General Surgeon, and Ob/Gyn equations. Physician density is negatively correlated with the number of patient visits in all equations but is significant in only one.

Translog Production Functions

Translog production functions have the advantage of being free of any specific functional form. To test of the appropriateness of the Cobb-Douglass assumption of a elasticity of substitution equal to one, we have estimated several translog equations. However the level of multicollinearity is great, even with the simplist equations. To demonstrate the severity of the problem, we report the estimations from an extremely simple specification.

$$(26)\quad V = b_0 + b_1 t_v + b_2 x_{v_1} + b_3 x_{v_2} + b_4 t_v x_{v_1} + b_5 t_v x_{v_2} + b_6 x_{v_1} x_{v_2}$$

where t_v is the log of patient office hours,
x_{v_1} is the log of expenditures on materials and supplies, and
x_{v_2} is the log of hours of registered nurses, licensed practical nurses, technicians, physician assistants, and nurse practitioners.

The equation estimates (Table 10) again indicate the significance of patient office hours with output elasticities in a similar range (.73 to 1.00) as the Cobb-Douglas parameters. Moreover since the three interaction terms are mostly insignificant, the Cobb-Douglas equations do not appear to be grossly inaccurate.

To demonstrate the level of multicollinearity generated by the translog formula, we have reported the 'Tolerance' statistic [63, p. 346] which is defined as 1 minus the R^2 of the independent variable regressed against all other included independent variables. A 'Tolerance' close to 1 indicates the lack of multicollinearity. Values such as the number of .01's which appear in each of the translog equations indicate extremely high collinearity.

SUMMARY AND CONCLUSIONS

The overall objectives of this research are increased understandings of the effects of different remuneration methods and of supplier-induced demand on physicians' incomes, practice inputs, and productivities. To achieve these ends we introduce a novel microeconomic model and analyse data from the HCFA-NORC Survey of Physicians' Practice Costs and Income. The model draws conclusions about how physician work-leisure choices are affected by four remuneration alternatives: fixed and output-, time-, and patient-based incomes. The empirical estimates examine the differences between salaried and fee-for-service physicians and between physician behavior in physician-dense versus physician sparce areas.

From a policy perspective, we have three sets of conclusions. The first and rather developed set deals with the implications of four different conceptual remunerations. The second evaluates the actual differences between salary and fee-for-service remunerations. The third examine the implications of physician behavior in physician dense geographic areas.

Optimal Remunerations

Using our model, we demonstrate the superiority of output-based income over fixed and time-based remunerations. The efficiency properties of output-based incomes will lead physicians to prefer them if either employers or competitive market conditions impose equal unit cost restrictions on the physicians. And consumers will prefer physicians who are paid an output-based income if the doctors move between remuneration systems until their utilities are equal.

The difficulty with the application of output-based incomes to the real world is that the output is certainly not knowable by consumers of medical care and may even be undefinable by physicians themselves. Therefore the most efficient remuneration is practically impossible.

As a result, the nation is forced to select among a number of second best alternatives each of which have some advantages and disadvantages. Physician payments based on their time at work and other practice inputs will generate too many of these inputs, at least when compared with the optimal levels defined by output-based remunerations. Since these inputs are costly, payments based on physician inputs will generate overly expensive medical care.

Physician incomes which are fixed (or which are based on the number of their patients) will have higher unit costs (Y/V), but may save expenditures because the quantities of medical care produced per patient may be less than for the more efficient output-based remuneration.

Fee-for-Service Versus Salary Incomes

By presuming that fee-for-service remuneration is at least partly based on medical care produced and that salary remuneration is in part a fixed remuneration, we derive several hypotheses from our model of physician work-leisure behavior. These include less income, less time at work, and less work expenditures for salaried physicians.

Our data from HCFA's Survey of Practice Costs and Income support the lower income, but indicate that salaried employees of single physicians work longer hours and make more patient visits per dollar of income. The data also indicate substantially lower incomes for female physicians, *ceteris paribus*.

Supplier-Induced Demand

We find that the density of physicians per capita in the county affects physician income and practice inputs in a manner consistent with the hypotheses either 1) of physician's flexibility to generate demand for office visits but not hospital visits, or 2) of a lagged adjustment to rising demand (which in turn must be negatively correlated with high incomes) of an inelastic demand for physicians' services in a hospital. Physician density decreases each physician's gross income, number of hospital visits, and hospital round hours.

We also find that physicians in low density areas use relatively more materials and supplies such as drugs, biologicals, and X-ray films. This second result is consistent with a substitutability in the production process and relatively inelastic demand for physician services.

Our results for hospital bed density suggest that hospital beds behave as machinery and equipment might in any worker's production function. Greater number of hospital beds per capita increase each physician's gross and net incomes, hospital round hours, and the number of hospital visits.

Future Research Directions

Research in the future contract years is to proceed in several directions. First, the microeconomic model will be generalized. We will use graphs to define and illustrate the degree to which our results depend upon the Cobb-Douglas production function. We will also extend our work on a single income constraint which includes the combination of all remuneration methods. This extension will allow consideration of physician behavior under a mixed system such as a combination of capitation and fee-for-service patients.

Second, we will extend our work by considering the effects of different and more sophisticated definitions of physicians productivity. Our single type of physician-patient contact output measure will be replaced with weighted combinations following Reinhardt [70] and Kimbell and Lorant [53].

Third, the model of physician work-leisure decisions is to be expanded to recognize the stochastic nature of the demand for physician's services and the effects of physician's preferences for or against risk.

Fourth, the effects of physician density on physician production activity are to be analyzed in greater depth. For example, we expect that the negative significance of office space and equipment cost may be attributable to the remaining significance of physician density and may disappear if the low physician-density observations are further divided by density.

Fifth, the effects of physician work preferences are to be developed. In our preliminary work, we have discovered that physicians who are pure work lovers will perform similarly no matter how they are paid. In additional work, we will develop the implications of physicians' work preferences as a determinant of the differences between physician behavior.

Finally, research in future years will detail the importance of free practice inputs to physicians who receive different forms of remuneration. Our initial work has suggested that free practice inputs are more likely to increase the efficiency of medical care delivered by salaried physicians. Yet to be developed are the optimal characteristics of the practice inputs to which physicians should have free access.

APPENDIX I:

FOUR REMUNERATION MODEL'S FIRST ORDER CONDITIONS

The first order conditions for the fixed income model are:

$$(27) \qquad \frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha\ U}{t_z} - \lambda_t = 0$$

$$(28) \qquad \frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha)\ U}{x_z} - \lambda_x = 0$$

$$(29) \qquad \frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta\ U}{t_v} - \lambda_t = 0$$

$$(30) \qquad \frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)\delta\ U}{x_v} - \lambda_x = 0$$

$$(31) \qquad \frac{\partial \pounds}{\partial n} = \frac{(1-\gamma)(1-\beta-\delta)\ U}{n} - \lambda_t\ t_d = 0$$

$$(32) \qquad \frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v - t_d \cdot n = 0$$

$$(33) \qquad \frac{\partial \pounds}{\partial \lambda_x} = Y_f - x_z - x_v = 0$$

The first order conditions for time-based remuneration are

$$(34) \qquad \frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha\ U}{t_z} - \lambda_t = 0$$

$$(35) \qquad \frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha)\ U}{x_z} - \lambda_x = 0$$

$$(36) \qquad \frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta\ U}{t_v} + w \cdot \lambda_x - \lambda_t = 0$$

$$(37) \quad \frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)\delta\ U}{x_v} - \lambda_x = 0$$

$$(38) \quad \frac{\partial \pounds}{\partial n} = \frac{(1-q)(1-\beta-\gamma)\ U}{n} - \lambda_t \cdot t_d = 0$$

$$(39) \quad \frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v - t_d \cdot n = 0$$

$$(40) \quad \frac{\partial \pounds}{\partial \lambda_x} = w . t_v - x_z - x_v = 0$$

The first order conditions for output-based income are

$$(41) \quad \frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha\ U}{t_z} - \lambda_t = 0$$

$$(42) \quad \frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha)\ U}{x_z} - \lambda_x = 0$$

$$(43) \quad \frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta\ U}{t_v} + \lambda_x \frac{P\beta\ V}{t_v} - \lambda_t = 0$$

$$(44) \quad \frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)\delta\ U}{x_v} + \lambda_x \frac{P\delta\ V}{x_v} - \lambda_x = 0$$

$$(45) \quad \frac{\partial \pounds}{\partial n} = \frac{(1-\gamma)(1-\beta-\gamma)\ U}{n} + \lambda_x \frac{P(1-\beta-\gamma)\ V}{n} + \lambda_t\ t_d = 0$$

$$(46) \quad \frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v - t_d \cdot n = 0$$

$$(47) \quad \frac{\partial \pounds}{\partial \lambda_x} = P . V - x_z - x_v = 0$$

The first order conditions for the capitation income model are:

$$(48) \quad \frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha\ U}{t_z} - \lambda_t = 0$$

$$(49) \quad \frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha)\ U}{x_z} - \lambda_x = 0$$

$$(50) \quad \frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta\ U}{t_v} - \lambda_t = 0$$

$$(51) \quad \frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)\delta\ U}{x_v} - \lambda_x = 0$$

$$(52) \quad \frac{\partial \pounds}{\partial n} = \frac{(1-\gamma)(1-\beta-\delta)\ U}{n} + \lambda_x\ p_n - \lambda_t\ t_d$$

$$(53) \quad \frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v - t_d . n = 0$$

$$(54) \quad \frac{\partial \pounds}{\partial \lambda_x} = Y_f - x_z - x_v = 0$$

APPENDIX II

THREE REMUNERATION MODEL'S FIRST ORDER CONDITIONS

The first order conditions for the fixed income model are:

(55) $$\frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha U}{t_z} - \lambda_t = 0$$

(56) $$\frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha) U}{x_z} - \lambda_x = 0$$

(57) $$\frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta U}{t_v} - \lambda_t = 0$$

(58) $$\frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)(1-\beta) U}{x_v} - \lambda_x = 0$$

(59) $$\frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v = 0$$

(60) $$\frac{\partial \pounds}{\partial \lambda_x} = Y_f - x_z - x_v = 0$$

The first order conditions for time-based remuneration are

(61) $$\frac{\partial \pounds}{\partial t_z} = \frac{\gamma\alpha U}{t_z} - \lambda_t = 0$$

(62) $$\frac{\partial \pounds}{\partial x_z} = \frac{\gamma(1-\alpha) U}{x_z} - \lambda_x = 0$$

(63) $$\frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma)\beta U}{t_v} + w.\lambda_x - \lambda_t = 0$$

(64) $$\frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)(1-\beta) U}{x_v} - \lambda_x = 0$$

$$(65) \quad \frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v = 0$$

$$(66) \quad \frac{\partial \pounds}{\partial \lambda_x} = w.t_v - x_z - x_v = 0$$

The first order conditions for output-based income are

$$(67) \quad \frac{\partial \pounds}{\partial t_z} = \frac{\gamma \alpha \; U}{t_z} - \lambda_t = 0$$

$$(68) \quad \frac{\partial \pounds}{\partial x_z} = \frac{\gamma (1-\alpha) \; U}{x_z} - \lambda_x = 0$$

$$(69) \quad \frac{\partial \pounds}{\partial t_v} = \frac{(1-\gamma) \beta \; U}{t_v} + \lambda_x \frac{P \beta \; V}{t_v} - \lambda_t = 0$$

$$(70) \quad \frac{\partial \pounds}{\partial x_v} = \frac{(1-\gamma)(1-\beta) \; U}{x_v} + \lambda_x \frac{P(1-\beta) \; V}{x_v} - \lambda_x = 0$$

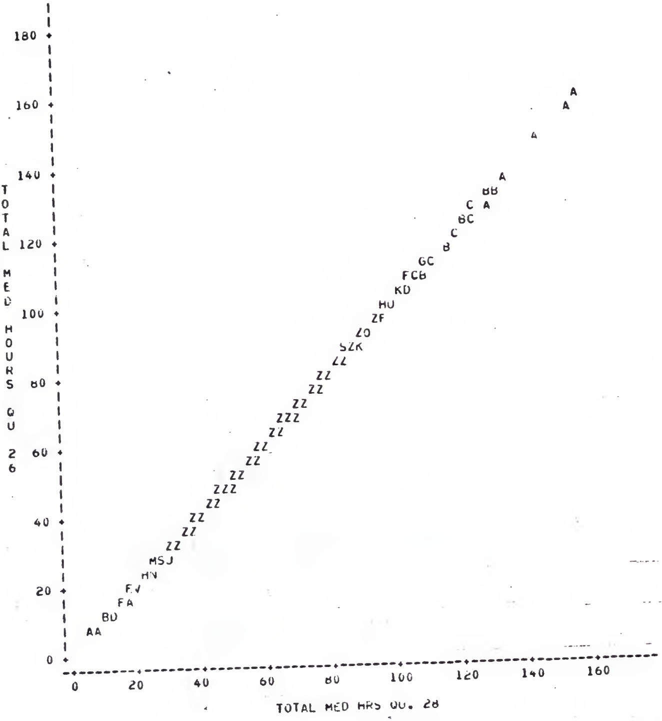
$$(71) \quad \frac{\partial \pounds}{\partial \lambda_t} = T - t_z - t_v = 0$$

$$(72) \quad \frac{\partial \pounds}{\partial \lambda_x} = P.V - x_z - x_v = 0$$

FIGURE AIII-1

```
S T A T I S T I C A L   A N A L Y S I S   S Y S T E M                    1
                                          10:37 MONDAY, MARCH 26, 1979

PLOT OF TOMEDHR1*TOMEDHR2    LEGEND: A = 1 OBS, B = 2 OBS, ETC.
```



```
NOTE:     19 OBS HAD MISSING VALUES    2361 OBS HIDDEN
```

Table AIII-1

Two Measures of Sharing Expenses

```
                    TABLE OF SHAREXP BY TYPEPRAC

SHAREXP   SOLO MD WHO SHARES EXPENSES   TYPEPRAC  TYPE OF PRACTICE

FREQUENCY|
PERCENT  |
ROW PCT  |
COL PCT  |       .|      1|      2|      3|      4|      5|  TOTAL
---------+--------+-------+-------+-------+-------+-------+
       . |      69|      1|      0|     64|    375|    777|      .
         |       .|      .|      .|      .|      .|      .|
         |       .|      .|      .|      .|      .|      .|
         |       .|      .|      .|      .|      .|      .|
---------+--------+-------+-------+-------+-------+-------+
       1 |       0|     21|    367|      1|      0|      0|    389
         |       .|   0.97|  16.87|   0.05|   0.00|      .|  17.88
         |       .|   5.40|  94.34|   0.26|   0.00|      .|
         |       .|   1.16|  99.73| 100.00|   0.00|      .|
---------+--------+-------+-------+-------+-------+-------+
       2 |       0|   1785|      1|      0|      1|      0|   1787
         |       .|  82.03|   0.05|   0.00|   0.05|      .|  82.12
         |       .|  99.89|   0.06|   0.00|   0.06|      .|
         |       .|  98.84|   0.27|   0.00| 100.00|      .|
---------+--------+-------+-------+-------+-------+-------+
TOTAL            .    1806     368       1       1       .    2176
                 .   83.00   16.91    0.05    0.05       .  100.00
```

Table AIII-2

Two Measures of Incorporation

```
                  TABLE OF TYPEPRAC BY INCORP

TYPEPRAC   TYPE OF PRACTICE   INCORP    PRACTICE 1 CORPORATED?

FREQUENCY|                                          (QU9)
PERCENT  |                      Incorp
ROW PCT  |
COL PCT  |       .  |       1  |       2  |  TOTAL
---------+----------+----------+----------+
       .  |      69  |       0  |       0  |     .
          |       .  |       .  |       .  |     .
          |       .  |       .  |       .  |
          |       .  |       .  |       .  |
---------+----------+----------+----------+
       1  |       0  |     632  |    1175  |   1807
          |       .  |   18.52  |   34.43  |  52.94
          |       .  |   34.98  |   65.02  |
          |       .  |   40.62  |   63.27  |
---------+----------+----------+----------+
       2  |       0  |     131  |     237  |    368
          |       .  |    3.84  |    6.94  |  10.78
          |       .  |   35.60  |   64.40  |
          |       .  |    8.42  |   12.76  |
---------+----------+----------+----------+
(QU 10 ff)|       0  |      14  |      71  |     85
 Unincorp |       .  |    0.41  |    2.08  |   2.49
   group  |       .  |   16.47  |   83.53  |
          |       .  |    0.90  |    3.62  |
---------+----------+----------+----------+
       4  |       0  |       2  |     374  |    376
          |       .  |    0.06  |   10.96  |  11.02
          |       .  |    0.53  |   99.47  |
          |       .  |    0.13  |   20.14  |
---------+----------+----------+----------+
       5  |       0  |     777  |       0  |    777
          |       .  |   22.77  |    0.00  |  22.77
          |       .  |  100.00  |    0.00  |
          |       .  |   49.94  |    0.00  |
---------+----------+----------+----------+
TOTAL            .       1556       1857       3413
                 .      45.59      54.41     100.00
```

Table AIII-3

Two Measures of Partnership or Group

Qu 8C

Qu 10 I

```
                 TABLE OF TYPEPRAC BY PARTGRPC

TYPEPRAC   TYPE OF PRACTICE    PARTGRPC   PARTNER GROUP CODE

FREQUENCY I
PERCENT   I
ROW PCT   I
COL PCT   I        .I       1I       2I  TOTAL
----------+---------+--------+--------+
        . I      69 I      0 I      0 I      .
          I       . I      . I      . I      .
          I       . I      . I      . I
          I       . I      . I      . I
----------+---------+--------+--------+
        1 I    1804 I      2 I      1 I      3
          I       . I   0.16 I   0.08 I   0.24
          I       . I  66.67 I  33.33 I
          I       . I   0.52 I   0.12 I
----------+---------+--------+--------+
        2 I     368 I      0 I      0 I      0
          I       . I      . I      . I   0.00
          I       . I      . I      . I
          I       . I      . I      . I
----------+---------+--------+--------+
        3 I       1 I      0 I     84 I     84
          I       . I   0.00 I   6.78 I   6.78
          I       . I   0.00 I 100.00 I
          I       . I   0.00 I   9.79 I
----------+---------+--------+--------+
        4 I       1 I    373 I      2 I    375
          I       . I  30.10 I   0.16 I  30.27
          I       . I  99.47 I   0.53 I
          I       . I  97.90 I   0.23 I
----------+---------+--------+--------+
        5 I       0 I      6 I    771 I    777
          I       . I   0.48 I  62.23 I  62.71
          I       . I   0.77 I  99.23 I
          I       . I   1.57 I  89.86 I
----------+---------+--------+--------+
TOTAL             .      381      858     1239
                  .    30.75    69.25   100.00
```

APPENDIX III

SURVEY INSTRUMENT RELIABILITY AND CONSISTENCY

As part of any major data analysis, a careful examination of each variable for consistency with expected frequency distributions and correlations with other variables is useful as a foundation upon which reliable results can be based. This Appendix to the Final Report presents a few troubling results of our screening. Although these doubts exist, we should note that the largest inconsistencies that have appeared represent less than 3% of the sample. A 3% error rate is very low.

First, we ask whether the data is internally consistent. If it is, then summary codes should contain the same information as the initial question. For example, Specialty from the the face or cover sheet should be equal to Specialty from Question 1-A. The distributions of these two questions suggests that Question 1-A was never coded. Additionally, the hours worked on Question 26 should approximate the hours worked from Question 28. Although discrepancies exist, no observation appears to be grossly off a diagonal plot (Figure AIII-1).

One serious discrepancy for this research on the effects of alternative remunerations is the difference between Question 10, the Interviewer Summary Box on the type of practice, and the detailed questions on which it should have been based. For example, there are 21 physicians (Table AIII-1) who answered that they did share expenses in Question 8A and who are coded as not sharing expenses in question 10-III. Similarly, there are 14 physicians who answered that their practice was incorporated in Question 9 but who are coded as in unincorporated groups in 10-III (Table AIII-2). Finally, there are 6 physicians who indicated they were in a partnership in Question 8C but who are coded as members of an incorporated group in 10-III (Table AIII-3).

After talking with Ms. Jackie Peterson of NORC by phone, we have presumed that the coding of Question 10-III is most accurate. Yet these errors do cast doubt on our capacity to assume that small specialty-remuneration cells contain reliable information. Moreover, we have not been informed on the results of any follow-up examination of these data inconsistencies.

Second, there are an insufficient number of observations for physicians of some remuneration types for a strong empirical analysis. The limited observations on salaried and prepaid physicians is a serious constraint. Of the 3342 total observations, only 69 are salaried and there are no salaried physicians in a prepaid group. And there are only 100 physicians whose practice is prepaid either in whole or in part.

Moreover, the concept of 'prepaid' appears to have been misinterpreted. By far the largest specialty group (28/100) among prepaid physicians are in Ob-Gyn. The next largest group (12) is General/Family Practice, followed by Psychiatry (11), Urology (9) and Ophthalmology (8). These

Table AIII-4

Prepaid Practices which Share Office Costs

```
              TABLE OF APREPAID BY SHARCSTO

APREPAID  PRACTICE ALL PREPAID?   SHARCSTO  SHARE COST OF OFFICE?

FREQUENCY|
PERCENT  |
ROW PCT  |
COL PCT  |       .|       1|       2|       9|  TOTAL
---------+--------+--------+--------+--------+
       . |   2943 |    370 |     51 |     18 |      .
         |      . |      . |      . |      . |      .
         |      . |      . |      . |      . |
         |      . |      . |      . |      . |
---------+--------+--------+--------+--------+
       1 |     11 |      3 |      0 |      1 |      4
         |      . |  21.43 |   0.00 |   7.14 |  28.57
         |      . |  75.00 |   0.00 |  25.00 |
         |      . |  30.00 |   0.00 | 100.00 |
---------+--------+--------+--------+--------+
       2 |     75 |      7 |      3 |      0 |     10
         |      . |  50.00 |  21.43 |   0.00 |  71.43
         |      . |  70.00 |  30.00 |   0.00 |
         |      . |  70.00 | 100.00 |   0.00 |
---------+--------+--------+--------+--------+
TOTAL           .       10        3        1       14
                .    71.43    21.43     7.14   100.00
```

Table AIII-5

Prepaid Practices Which Share Office Equipment Costs

```
              TABLE OF APREPAID BY SHARCSTE

APREPAID  PRACTICE ALL PREPAID?   SHARCSTE  SHARE COST OF OFFICE EQ

FREQUENCY|
PERCENT  |
ROW PCT  |
COL PCT  |       .|       1|       2|       9|  TOTAL
---------+--------+--------+--------+--------+
       . |   2943 |    263 |    158 |     18 |     .
         |      . |      . |      . |      . |     .
         |      . |      . |      . |      . |
         |      . |      . |      . |      . |
---------+--------+--------+--------+--------+
       1 |     11 |      1 |      2 |      1 |      4
         |      . |   7.14 |  14.29 |   7.14 |  28.57
         |      . |  25.00 |  50.00 |  25.00 |
         |      . |  14.29 |  33.33 | 100.00 |
---------+--------+--------+--------+--------+
       2 |     75 |      6 |      4 |      0 |     10
         |      . |  42.86 |  28.57 |   0.00 |  71.43
         |      . |  60.00 |  40.00 |   0.00 |
         |      . |  85.71 |  66.67 |   0.00 |
---------+--------+--------+--------+--------+
TOTAL           .        7        6        1       14
                .    50.00    42.86     7.14   100.00
```

Table AIII-6

Prepaid Practices Which Share Office Personnel Costs

```
                 TABLE OF APREPAID BY SHARCSTP

APREPAID  PRACTICE ALL PREPAID?    SHARCSTP  SHARE COST OF OFFICE PERSONN

FREQUENCY|
PERCENT  |
ROW PCT  |
COL PCT  |       .|       1|       2|       3|       9|  TOTAL
---------+--------+--------+--------+--------+--------+
       . |   2943 |    129 |    110 |    182 |     18 |      .
         |      . |      . |      . |      . |      . |      .
         |      . |      . |      . |      . |      . |
         |      . |      . |      . |      . |      . |
---------+--------+--------+--------+--------+--------+
       1 |     11 |      1 |      0 |      2 |      1 |      4
         |      . |   7.14 |   0.00 |  14.29 |   7.14 |  28.57
         |      . |  25.00 |   0.00 |  50.00 |  25.00 |
         |      . |  20.00 |   0.00 |  28.57 | 100.00 |
---------+--------+--------+--------+--------+--------+
       2 |     75 |      4 |      1 |      5 |      0 |     10
         |      . |  28.57 |   7.14 |  35.71 |   0.00 |  71.43
         |      . |  40.00 |  10.00 |  50.00 |   0.00 |
         |      . |  80.00 | 100.00 |  71.43 |   0.00 |
---------+--------+--------+--------+--------+--------+
TOTAL             .        5        1        7        1       14
                  .    35.71     7.14    50.00     7.14   100.00
```

```
STATISTICAL ANALYSIS SYSTEM                              2
                         14:01 WEDNESDAY, MARCH 28, 1979

      PLOT OF PATOFFHRS*NOPATVST    SYMBOL IS VALUE OF MEMUTYPE
```

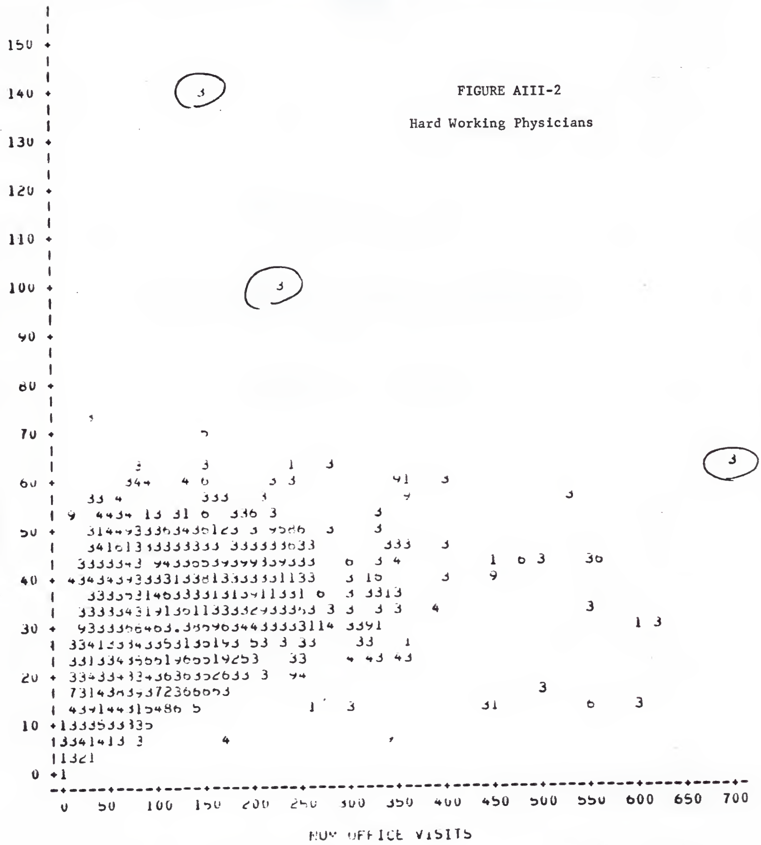


FIGURE AIII-2

Hard Working Physicians

```
NOTE:     69 OBS HAD MISSING VALUES    3527 OBS HIDDEN
```

distributions suggest that a substantial proportion of the respondents may have interpreted 'prepaid' to mean payment before medical care delivery but after risk (eg. pregnancy) is established. This potential mixing of payment based on output (normal delivery) and payment based on the number of patients substantially reduces the usefulness of the 'prepaid' question.

Additional questions about the interpretation of the 'prepaid' physicians are suggested by the frequency counts of prepaid physicians who share expenses. The accepted concept of a prepaid group implies that physicians should share expenses. Yet only 10, 7, and 5 of the 100 prepaid physicians state that they share expenses of office space, equipment, and non-physician personnel, respectively (Tables AIII-4 to AIII-6). Both these problems with the 'prepaid' question make it unlikely that the 'prepaid' question will have any analytic usefulness.

Third, there are a few extreme observations which lead one to question their credibility. For example, there is one solo physician who has 140 office hours per week yet handles only approximately 179 office visits during the same time period (Figure AIII-2). At the other extreme, there is another solo physician who sees 700 office visits per week but works about a 63 hour week. At the low end, there are a group of physicians who have some number of office patient visits with zero patient office hours. After performing some preliminary tests which determined that deleting the extreme observations did not substantially affect the regression results, we left all outliers in the sample.

Recommendations

For the purposes of this type of research, it is as important to have as large a number of observations of different remuneration types as it is to have a sufficient number of observations of each specialty. Strong policy conclusion about the efficiency of alternative remunerations require examination of substantially greater numbers of salaried and correctly identified prepaid physicians. Therefore in the coming year's sample we recommend that

(1) The number of salaried and prepaid physicians be oversampled in the same way that certain specialties appear to have been oversampled in the 1976 files;

(2) The interviewers clarify their definition of 'prepaid' so that it corresponds to the physician's assuming the financial risk of a patient's future medical treatments.

The 1976 File does not ask about the physician's use of practice inputs for salaried physicians. It is therefore impossible to determine exactly how the salaried physician uses practice inputs differently from his fee-for-service counterparts. We additionally recommend that

(3) Salaried employees be asked to estimate his practice's use of office space, utilities, medical equipment, medical materials and supplies (Question 42) in a manner exactly parallel to that now requested of the physician partner or group member.

APPENDIX IV

VARIABLE DEFINITIONS

Income and Practice Input Equations

GRSINCSO	Physician's own practice gross income for unincorporated physicians, measured in $10,000.
NETINC	Physician's own net income, measured in $10,000.
OFFHR &/or PATOFFHR	Patient office hours per week
HSPRNDHR	Hospital round hours per week
TOMEDHR2	Total medical hours per week (using the second estimate on the questionnaire)
MEDDED	Medical deductions from the physician's own practice, for unincorporated physicians, measured in $1,000
NOPATVST	Number of patient visits during the week in the physician's office
NOHSPVST	Number of patients visited in the hospital during the week.

OFHRPNIN = PATOFFHR / NETINC

HSHRPNIN = HSPRNDHR / NETINC

TMHRPNIN = TOMEDHR2 / NETINC

MDEDPNIN = MEDDEDSO / NETINC

OVSTPNIN = NOPATVST / NETINC

HVSTPNIN = NOHSPVST / NETINC

Remuneration Type of the Intercept	Solo physician not sharing expenses
Remuneration Type 1	Salaried physician employed by a single physician
Remuneration Type 2	Salaried physician employed by a group of physicians
Remuneration Type 4	Solo physician sharing expenses with other physicians

APPENDIX IV (continued)

Remuneration Type 7	Member of unincorporated group not sharing expenses
Remuneration Type 8	Member of unincorporated group sharing expenses
Prepaid	A dummy variable set to 1 if some of the physicians patients are 'prepaid.'
Specialty Type of the Intercept	General/Family Practice
Specialty Type 6	General Surgery
Specialty Type 7	Internal Medicine
Specialty Type 11	Obstetrics/Gynecology
Specialty Type 15	Pediatrics / Pediatric Surgery
Specialty Type 16	Psychiatry / Child Psychiatry

MDDEN = The number of physicians in the county in 1976 divided by the county's estimated population (in 1,000) in 1976

PI = The county's Personal Income of individuals over 14 year old.

POPDEN = The county's population density

POP70YOP = The percent of the county's population under 4 years and over 65 years

EDUCMED = The county's median education level

Production Functions

PATOFFHR = Log of the physician's patient office hours

OTHMDHR = Log of the physician's total medical hours minus patient office hours,

SUPLYCST = Log of expenditures on medical materials and supplies,

APPENDIX IV (continued)

OFSPCCST = Log of expenditures on office space and equipment,

MEDEQCST = Log of expenditures on medical equipment,

NONMDHRS = Log of the sum of hours of the physician's registered nurses, licensed practical nurses, medical technicians, physician assistants, and nurse practitioners.

APPENDIX V

TABLE 5

Regression Results for Physician Income and Practice Inputs

Dependent Variable	Intercept	Remuneration Type					PRE-PAID	FEMALE	FMG	ZURBPOP	MDAGE GROUP				Specialty Type					R^2 F
		1	2	4	7	8					30	40	60	70	6	7	11	15	16	
GRSINCSQ (X̄=4.75)	6.03 .25[a]	-2.72 .62[a]	-1.63 .43[a]	-.05 .19	2.69 .72[a]	.75 .37[c]	-1.15 .48[c]	-1.73 .27[a]	-.30 .19	-.00046 .00029	-.37 .21	.22 .20	-1.14 .20[a]	-2.85 .29[a]	.81 .24[a]	-.09 .27	.56 .27[c]	-.23 .26	-1.34 .23[a]	.25 19.19[a]
NETINC (X̄=4.58)	5.02 .25[a]	-1.40 .60[c]	-.26 .43	.09 .19	2.07 .70[b]	.71 .37	-.53 .47	-1.49 .27[a]	-.11 .19	-.00032 .00028	-.16 .21	.35 .20	-.74 .20[a]	-2.06 .29[a]	.94 .24[a]	.15 .26	.61 .27[c]	-.22 .25	-.09 .23	.15 9.22[a]
PATOFHR (X̄=26.66)	34.50 1.13[a]	.34 2.76	.62 1.93	.01 .86	-3.96 3.21	2.07 1.67	-4.92 2.13[c]	-.63 1.21	-1.44 .85	-.00159 .00130	-2.31 .94[c]	-.21 .88	-1.19 .92	-3.00 1.31[c]	-13.30 1.09[a]	-3.47 1.18[b]	-7.79 1.21[a]	3.70 1.15[b]	-2.13 1.03[c]	.23 16.45[a]
HSPRVHR (X̄=8.91)	11.48 .79[a]	4.43 1.93[c]	-1.15 1.34	-.62 .60	2.96 2.24	1.60 1.17	-.87 1.48	-1.60 .84	.59 .59	-.00249 .00090[b]	-.06 .66	.69 .61	-.72 .64	-3.60 .91[a]	4.05 .76[a]	4.42 .83[a]	-.43 .84	-1.49 .80	-4.64 .72[a]	.23 16.37[a]
T[illegible]2 (X̄=57.[illegible])	64.07 1.97[a]	12.78 4.56[b]	-4.16 3.19	-1.43 1.42	3.38 5.30	2.91 2.76	-5.92 3.52	-3.68 2.00	.93 1.40	-.00272 .00214	-1.29 1.55	1.39 1.45	-3.37 1.51[c]	-11.90 2.16[a]	1.77 1.80	.43 1.96	-3.32 1.99	-1.73 1.91	-9.35 1.71[a]	.11 7.23[a]
[illegible] (X̄=3.19)	4.37 .27[a]	-2.50 .69[a]	-1.91 .49[a]	-.28 .21	4.63 .75[a]	.71 .43	-.40 .51	-.58 .34	-.52 .22[c]	-.00018 .00032	-.17 .23	.33 .22	-.70 .23[b]	-1.99 .34[a]	-.19 .28	-.59 .30[c]	.40 .30	-.36 .29	-2.25 .26[a]	.25 14.67[a]
NPATVST (X̄=84.51)	167.07 6.32[a]	-16.13 15.32	1.87 10.69	-3.32 4.76	18.81 17.80	4.80 9.27	-1.96 12.06	-16.01 6.76[c]	-12.02 4.73[c]	-.03857 .00722[a]	-7.78 5.24	7.37 4.86	-9.97 5.10	-28.00 7.33[a]	-70.28 6.06[a]	-47.45 6.59[a]	-50.13 6.69[a]	5.23 6.41	-90.09 5.75[a]	.37 32.35[a]
NHSPVST (X̄=37.12)	61.43 4.41[a]	1.35 10.24	-5.88 7.01	.62 3.46	24.98 11.59[c]	13.45 6.14[c]	6.46 8.49	-11.78 4.96[c]	-6.33 3.23	-.02505 .00499[a]	3.45 3.75	.39 3.41	-9.95 3.57[b]	-21.85 5.63[a]	19.97 4.06[a]	5.48 4.37	-8.87 4.45[c]	-11.70 4.32[b]	-18.43 4.39[a]	.27 10.53[a]
OFHRPVIS (X̄=7.91)	8.69 .56[a]	3.99 1.36[b]	-.29 .96	-.16 .43	-2.82 1.57	.08 .84	.23 1.07	4.11 .61[a]	-.43 .43	-.00026 .00064	-.49 .47	-.85 .44	.70 .46	3.54 .66[a]	-4.10 .55[a]	-.65 .59	-2.47 .61[a]	1.44 .58[c]	-.63 .51	.27 13.03[a]
HSHRPVIS (X̄=2.2[illegible])	2.45 .25[a]	3.82 .61[a]	-.29 .43	-.15 .19	-.44 .71	.28 .38	.41 .48	.42 .28	.39 .19[c]	-.00034 .00029	-.15 .21	-.08 .20	.02 .21	-.29 .30	.75 .25[b]	1.32 .27[a]	-.12 .27	-.19 .26	-1.12 .23[a]	.17 10.81[a]
TOHRPVIS (X̄=15.49)	15.39 .97[a]	11.98 2.34[a]	-1.83 1.66	-.49 .74	-3.04 2.71	-.27 1.45	1.22 1.84	6.73 1.06[a]	.54 .74	.00025 .00111	-.10 .81	-1.28 .76	1.01 .79	4.29 1.15[a]	-2.01 .94[c]	.78 1.02	-1.62 1.05	.29 .99	-2.55 .89[b]	.12 7.43[a]
MEDDFSIN (X̄=.73)	.92 .07[a]	-.33 .16[c]	-.50 .12[a]	-.06 .05	.64 .18[a]	.12 .10	.06 .12	.19 .08[c]	-.12 .05[c]	.00004 .00008	-.03 .06	.02 .05	-.07 .05	-.18 .08[c]	-.15 .07[c]	-.17 .07[c]	-.01 .07	.06 .07	-.49 .06[a]	.19 9.37[a]
OFSTFSIN (X̄=21.65)	41.34 1.95[a]	6.46 4.69	.61 3.32	-1.25 1.49	-2.04 5.44	.27 2.91	6.60 3.78	6.70 2.14[b]	-2.93 1.49[c]	-.01029 .00223[a]	-1.99 1.63	-.30 1.53	.28 1.59	.39 2.32	-20.15 1.89[a]	-10.76 2.06[a]	-14.61 2.11[a]	1.57 1.99	-21.70 1.78[a]	.30 23.00[a]
HOSTFSIN (X̄=8.21)	13.14 .96[a]	5.69 2.20[b]	-1.10 1.53	-.42 .76	-.18 2.48	1.74 1.33	3.40 1.88	.69 1.10	-.99 .71	-.00542 .00108[a]	1.37 .82	-.79 .75	-.92 .78	-2.45 1.24[c]	2.26 .69[c]	1.74 .95	-2.02 .98[c]	-2.13 .94[c]	-4.12 .96[a]	.15 6.96[a]

NOTES: [a] indicates significance at the .001 level. [b] indicates significance at the .01 level. [c] indicates significance at the .05 level.
All equations were estimated using the Type IV Sums of Squares calculated by the GLM Procedure of SAS79 on the Washington University IBM 360.
Intercept values are for male general practioners who are in solo practice and are between 50 and 59 years old.
Regression coefficients are reported over their standard errors.

APPENDIX VI

Questions from
The HCFA/NORC Survey of Physician Practice Costs and Income

*25. Altogether, during last week, about how many hours would you say you yourself spent at administrative activities connected with your practice(s)? Include such activities as filling out health insurance forms, billing patients, dealing with personnel or financial matters of the practice.

______ Total # of hours at administrative activities 38-40/

---

26. Altogether, during the 7 days last week, about how many hours would you say you spent working at medical activities? Include hours spent in the office, time spent on house calls including travel, time spent on hospital rounds, hours spent in a hospital clinic or other medical facility, consulting with other physicians and time devoted to other professional activities.

______ Total # of hours at medical activities 41-43/

	27. During this period, that is, the 7 days last week, how many of these hours did you spend . . .			FOR EACH ITEM IN Q. 27 WITH ANY HOURS, ASK: 29. During last week, how many . . .	
A.	with patients in the office?	______ hours None. . . 0	A.	patient visits did you yourself have in your office?	______ patient visits
B.	on house calls, including travel time?	______ hours None. . . 0	B.	house calls did you make?	______ house calls
C.	on hospital rounds with your private patients?	______ hours None. . . 0	C.	in-patient visits did you make on hospital rounds excluding visits to patients seen in emergency rooms or out-patient settings? Count as one visit every time you saw a patient.	______ in-patient visits
D.	in the hospital emergency room and out-patient clinics?	______ hours None. . . 0	D.	patients did you see in the hospital emergency rooms or hospital out-patient clinics?	______ patients
E.	on operations and surgical assists, including normal deliveries and time waiting at the hospital to operate?	______ hours None. . . 0	E.	operations and assists did you participate in?	______ operations
F.	with patients in nursing homes, convalescent homes, or extended care facilities including travel time?	______ hours None. . . 0	F.	patients' visits did you make in nursing homes, convalescent homes, or extended care facilities, counting as one visit every time you saw a patient?	______ patient visits
G.	consulting with other physicians?	______ hours None. . . 0			
H.	traveling among offices, hospital and clinics?	______ hours None. . . 0			
I.	at other professional activities, such as professional reading, writing, research, lecturing or medical meetings?	______ hours None. . . 0			
	IF VOLUNTEERED				
J.	Other (SPECIFY) ______________	______ hours None. . . 0			

35. During last week, for approximately what percentage of your office visits did you order a . . .

A. lab procedure or test? ________% 37-39/

B. injection or immunization? ________% 40-42/

C. X-ray or fluoroscopy? ________% 43-45/

D. office surgical treatment? ________% 46-48/

E. NO PATIENT VISITS. 0 49-51/

42. How much was (your/your partnership or group's) yearly cost in 1976 for . . .

1. office space and utilities? $__________/Nothing . . 0 11-16/

2. medical equipment? $__________/Nothing . . 0 17-22/

3. medical materials and supplies such as drugs, biologicals, and X-ray films? $__________/Nothing . . 0 23-28/

48. *A. In 1976, what were the actual total yearly wages for those physician employees?

$__________ physician employee wages 31-37/

*B. Altogether, how many hours per week did they work?

______ hours per week 38-41/

BEGIN CARD 07

*53. In 1976, how many (EMPLOYEE TYPES) were there in your practice?

		IF ANY EMPLOYEE TYPES, ASK A & B	
		A. Altogether, how many hours did (EMPLOYEE TYPE(S)) work per week?	B. What was the total weekly salary for the/these (EMPLOYEE TYPE(S))?
	# IN PRACTICE	HOURS PER WEEK	TOTAL WEEKLY SALARY
1. secretaries, bookkeepers, receptionists, or office managers?	______ None. . . 0 11-13/	14-17/	$ 18-22/
2. registered nurses?	______ None. . . 0 23-25/	26-29/	$ 30-34/
3. licensed practical nurses?	______ None. . . 0 35-37/	38-41/	$ 42-46/
4. medical, X-ray or laboratory technicians or aides?	______ None. . . 0 47-49/	50-53/	$ 54-58/
5. highly trained physician extenders such as physician assistants and nurse practitioners?	______ None. . . 0 59-61/	62-65/	$ 66-70/

IF EMPLOYEE, UNINCORPORATED SOLO OR UNINCORPORATED GROUP PRACTICE, ASK Q's. 55-57

*55. In which of these broad groups was your own gross income from medical practice in 1976 before practice deductions and taxes? Was it . . .

1. less than $40,000, ... 01 11-12/
2. $40,000 to less than $50,000,. 02
3. $50,000 to less than $60,000,. 03
4. $60,000 to less than $70,000,. 04
5. $70,000 to less than $80,000,. 05
6. $80,000 to less than $90,000,. 06
7. $90,000 to less than $100,000, ... 07
8. $100,000 to less than $150,000,. 08
9. $150,000 to less than $200,000,. 09
10. $200,000 or over?. . . About how much was that? $__________ 10 13-18/

*61. What were your total deductions during 1976 for the partnership or corporation?

$________________ 54-60/

ASK EVERYONE

*62. In which of these broad groups was your own net income from the practice of medicine in 1976 after practice deductions and before taxes? Was it . . .

1. less than $20,000,. 01 61-62/
2. $20,000 to less than $30,000, . . . 02
3. $30,000 to less than $40,000, . . . 03
4. $40,000 to less than $50,000, . . . 04
5. $50,000 to less than $60,000, . . . 05
6. $60,000 to less than $70,000, . . . 06
7. $70,000 to less than $80,000, . . . 07
8. $80,000 to less than $90,000, . . . 08
9. $90,000 to less than $100,000,. . . 09
10. $100,000 or over?. . . About how much was that? $______________ 10 63-68/

APPENDIX VII

PAYING THE DOCTOR: A MODEL OF WORK-LEISURE DECISIONS UNDER ALTERNATIVE REMUNERATIONS

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I. Introduction

Whether we call them "consumer agents" [3] or "team captains" [4], physicians significantly determine each patient's expenditures and use of medical care resources. This insight, coupled with this Nation's rapidly rising medical care expenditures, has generated a growing body of literature on factors, such as physician remuneration, which affect the physician's efficient use of medical care resources. Alternative remuneration systems are of particular interest since they afford the prospect of decentralized market incentives, rather than bureaucratically-imposed direct controls.

Despite this interest, models which thoroughly represent the effects of more than two alternative remunerations are scarce, even within usually rigorous economic manuscripts. The well-known income-leisure framework ignores the role of practice inputs other than the physician's labor. The profit maximization model can only compare output-based and fixed incomes. Neither model, nor any modification based on the unmeasureable "work effort", is capable of a full comparision of fixed, time-, and output-based incomes.

This paper introduces a model with two features which facilitate the comparison of work-leisure and input choice decisions under all these remuneration methods. First, physicians are assumed to derive satisfaction from both work and leisure activities. Second, earned income is presumed to be spent on (and time is allocated between) both work and leisure.

The analysis proceeds as follows. In the next section, we introduce the model's fundamental characteristics. In section III we consider the physician practice input and ouput solutions in situations 1) where physicians face unit prices which leave them indifferent between remuneration methods, 2) where third-party payors set gross physician income but leave physicians to select among alternative types of remuneration, and 3) where users are able to set unit costs leaving physicians to select the remuneration method they most prefer. In sections IV and V we introduce and analyze data from the Health Care Financing Administration (HCFA) 1976 Survey of Physician Practice Costs and Income to estimate the effects of alternative remunerations on the use of certain practice inputs.

II. Physician Work-Leisure Model

Our model presumes that each physician derives utility from professional activities, measured by medical care production V, and from the consumption of the product of his leisure activities Z.

(1) $U = U(V,Z)$

where U is utility level,
V is total production of medical care,
Z is total production (and consumption) of leisure activities,
$U_V > 0$, and $U_Z > 0$.

The use of production of leisure activities rather than leisure time and net income in the utility function follows Becker[1]. Our assumption that a doctor derives satisfaction from his professional activity, measured by production of medical care, is less common. Scitovsky recognized the issue 27 years ago.

> Artists, scientists, professional people, and business men often regard their work not merely as a means of earning income but as an important and interesting part of their lives [5, p. 87].

More recently Enthoven has defined physicians' joint objectives.

> Physicians and other health professionals are motived by non-financial goals, including a desire to cure the sick and to achieve professional excellence and esteem of peers and public. But their use of resources is inevitably shaped by financial incentives [2].

Our model includes medical care output in the utility function as a direct representation of the first of Enthoven's professional objectives. Demonstrating exactly how financial incentives can shape physicians' use of resources is the main focus of the research.

An exact definition of the medical care output V is unnecessary for this conceptual research. The usual empirical indexes of physicians' production, such as patient contacts or billings, are simply not good measures of changes in patients' health. Although Health Status Indexes ask the relevant questions, they are inadequately developed to be generally useful. In this theoretical section, medical care output V is assumed to be some undefined combination of improved patient characteristics, such as increased longevity, reduced pain or suffering, and increased psychological satisfaction. The purposes of this conceptual model are satisfied by assuming only that each physician behaves as if he or she understands the definition of medical care.[1]

In a manner identical to Becker, we assume physicians produce leisure using consumer purchases x_z and their own time t_z.

(2) $Z = Z(x_z, t_z)$

where Z is production of leisure activities,
x_z is purchased consumer goods,
t_z is leisure time,
$Z_{x_z} > 0$, and $Z_{t_z} > 0$.

Of course, one of Becker's leisure activities could easily be work. By using such a specification, we have a work production function where output V is produced using intermediate market goods x_v and time t_v,

(3) $V = V(x_v, t_v)$

where V indicates the quantity of work output (medical care) produced,
x_v are quantities of (practice) inputs purchased with income,
t_v is the individual's (physician's) time at work, $V_{x_v} > 0$, and $V_{t_v} > 0$.

Introducing purchased intermediate inputs in the work production process is an uncommon, but easily understood, specification. It represents a combination of the production function of a profit maximization model with the utility maximand of the income-leisure model. Physicians' purchases are their practice inputs, including office space, equipment and personnel.

The physician's behavior is constrained by his income and by his time which he allocates between work and leisure. The income and time constraints are

(4) $Y = x_v + x_z$ and

(5) $T = t_v + t_z$

where Y indicates gross physician real earnings, ie. gross dollar earnings divided by the price of goods[2],
x_v is purchases of practice inputs,
x_z is purchases of consumption goods for leisure purposes,
T is total time,
t_v is time at work, and
t_z is time spend on leisure activies.

In the context of this model, we consider three simplisitic remuneration alternatives. The first is fixed income regardless of the physician's activities. The second is a payment proportional to the physician's time at work. The third is payment which is proportional to the physician's medical care production.[3] In the economic literature, time-based incomes are wages, while output-based remuneration may be called "piece rates" or "sharecropping" or, among physicians, "case rates".

Because our two empirically observed remuneration alternatives, fee-for-service and salary, do not correspond directly to any of the simple remuneration alternatives, we retain the use of the somewhat pedantic "fixed", "time-based", and "output-based" terminology. Later in the paper we shall derive empirically testable hypotheses from the assumption that salaries consist of a combination of time-based and fixed incomes and that fees-for-services are combinations of time and output-based remunerations.

The simplest income is fixed; the physician receives a predetermined remuneration per time period regardless of his activities during that period.

(6) $Y = Y_f$ where Y_f is exogenously determined.

Wages are a second remuneration method, although physicians receive them infrequently. If MD's were paid wages, income would be directly proportional to their hours of work time.

(7) $Y = w.t_v$ where w is an exogenous wage rate

Case rates refer to treatment of specific conditions, such as a normal delivery, and most clearly correspond to a payment per unit of health care output. Such remuneration is fixed per unit of output regardless of the physician's time or use of machinery and equipment.

(8) $Y = p.V$

where p_v is an exogenously determined price per unit of health care output.

The general Lagrangian expression for this work-leisure model is

$$(9)\quad \mathcal{L} = U[Z(x_z, t_z),\ V(x_v,\ t_v)]\ +\ \lambda_t(T - t_z - t_v)\ +\ \lambda_x(Y - x_z - x_v)$$

III. Solutions to a Cobb-Douglas Constant Returns to Scale Model

The following Cobb-Douglas model with constant returns to scale has been solved for fixed, time-based, and output-based remunerations.[4]

(10) $U = Z^{\gamma}\, V^{(1-\gamma)}$

(11) $Z = t_z^{\alpha}\, x_z^{(1-\alpha)}$

(12) $V = t_v^{\beta}\, x_v^{(1-\beta)}$

(13) $T = t_z + t_v$

(14) $Y = x_z + x_v$

The Lagrangian for this model is

$$(15)\quad \mathcal{L} = t_z^{\gamma\alpha} \cdot x_z^{\gamma(1-\alpha)}\ t_v^{(1-\gamma)\beta}\ x_v^{(1-\gamma)(1-\beta)} + \lambda_t(T - t_z - t_v) + \lambda_x(Y - x_z - x_v)$$

where $Y = Y_f$, $Y = w.t_v$, or $Y = p.V$

A. Endogenous Variables

Table 1 reports the general comparative solutions derived from the first order conditions for each remuneration alternative. One immediate strong result of the Cobb-Douglas formulation is apparent for all three payment mechanisms: the allocation of time between work and leisure is independent of 1) the amount of income and in some cases 2) the kind of income. In all three remuneration types, the time at work and the time at leisure have no parameters which reflect the level of income. The allocations of time are completely determined by the exponents α, β, and γ and total time T. Moreover, constant returns to scale lead to identical allocations of time between wage and output-based incomes. Decreasing returns to scale in the work production function would cause the time at work to be greatest for wage income, less for output-based income, and least for fixed income. Still, decreasing returns do not change the independence of the time allocations from any influence of income.

Table 2 reports the endogenous variable ranks for equal utility, equal income, and equal costs. The "equal utility" assumption describes a market which would exist if physicians were sufficiently mobile between remuneration methods to force the market to adjust Y, w and P to leave physicians at an equal utility level. This market implies that purchasers bear the entire cost burden of any inefficiencies generated by suboptimal remuneration methods.

The "equal income" assumption describes a market where physicians would earn equal gross income under each remuneration method. This equilibrium could be generated by an omnipotent third-party payor who was able to adjust the remuneration rates to equalize physicians' gross incomes. This implies that physicians on fixed incomes do better (have higher utility levels) than their more efficient output-based income counterparts. Therefore patients of fixed income physicians face even higher relative unit costs than they face under the equal physician utility assumption. This solution also clarifies the importance of the remuneration method as opposed to the remuneration amounts.

The "equal cost" assumption describes a market where physicians are assumed to accept a fixed unit cost level regardless of the type remuneration. This type of market implies that patients are aware of, and chose physicians on the basis of, the costs of medical care and are indifferent to how physicians are paid. In such a market, physicians absorb all costs associated with inefficient production generated by suboptimal remuneration methods.

Despite the different market assumptions, the rankings of endogneous variables reported in Table 2 are remarkably similar. In addition to the already reported determinancy of the time allocations, the rankings of leisure activities, medical care production, and unit costs are unaffected by whether utility or gross income is assumed equal between remuneration methods. Leisure activities are greatest under a fixed income, intermediate for time-based income and least for output-based income. Conversely, the production of medical care is greatest for output-based income, intermediate for time-based income, and least for fixed income. The per unit cost of medical care production is least for output-based income, intermediate for time-based income and greatest for fixed income.

The physician's use of practice inputs is affected by the market assumptions. Where gross incomes are equal, the physician's work expenditures are equal for time-based and fixed income. Where the physician's utility is assumed equal, practice inputs for time-based inputs are larger than those for fixed incomes.

In summary, we have a number of intuitively plausible hypotheses. First, physicians paid on the basis of their delivery of medical care produce the most output at the least cost. Second, physicians paid based on their time at work spend the greatest amount of time at work relative to practice inputs, to the point of being inefficient. Third, physicians paid a fixed income are happiest per dollar of income and enjoy the greatest amount of leisure.

Additionally, we have a deterministic dynamic model. If physicians are price takers at unit costs which are equal for all remuneration systems, they maximize their utility by selecting output-based incomes. If physicians are mobile between remuneration methods which are selected by consumers, price-conscious consumers will cost minimize by selecting an output-based remuneration method. In general, with perfect information and zero transaction costs, output-based incomes will always be chosen since they are Pareto superior to both fixed and time-based remunerations.

Finally, examination of the Table 1 solutions shows that the utility gained from work activities tends to mitigate the effects of remuneration alternatives. For example, work haters on a fixed income produce only leisure and generate infinite unit costs of work. At the extreme, pure work lovers (or leisure haters) are totally unaffected by the form of their income. By implication, if payment mechanisms other than output-based are to be used, there are advantages to be gained from physician education procedures (such as extended internship-residency requirements) which would tend to screen out work-haters and encourage work-lovers.

B. Qualifications

The results we have reported are not perfectly general. First, graphical analyses reported elsewhere [6] indicate that the variable rankings are indeed sensitive to the unitary elasticity of substitution of the Cobb-Douglas function form. For example, a less than unitary elasticity of substitution between work and leisure in the utility function reverses the rank of the medical care production of time-based and fixed income. With this smaller elasticity, a physician paid a fixed income will produce more medical care than he would for the same time-based income. Alternatively, if all production and utility functions were Leontief, the three systems would produce identical results. This sensitivity to elasticities of substitution argues for some generalization of the functional forms assumed. But solutions for even the next most general function, Constant Elasticity of Substitution, would be extremely difficult arithmetically without much additional generality. Thus a graphical generalization seems preferable.

We should note, however, that even though the results we report are at the extreme forms of remuneration, there appears tu be no switching for the Cobb-Douglas functions. For example, as the proportion of total income derived from time-based rather than fixed income increases, time spent at work increases monotonically. This statement is based on some preliminary solutions for a unified model with all three remuneration types included in the income constraint.

Second, our model does not address attempts by any physician employer to directly control input levels. In general, we might well expect employers to intervene with ancillary controls to offset the distortions introduced under fixed income and time-based systems. Two ancillary controls are often observed. The first is the requirement of a minimum number of hours at work. Given our assumptions, we would expect to observe ancillary minimum-time constraints with fixed-income systems, but not with time-based systems unless team coordination is required.

The second expected ancillary control is over the level of production inputs. For example, a salaried physician is likely to find his employer providing a number of practice inputs which the fee-for-service doctor would have to buy. In addition, all types of physicians may have access to hospital equipment and personnel at no marginal cost to them.[5]

Comparing fixed and time-based systems under the Cobb-Douglas assumptions, x_v is the same but t_v is greater under a time-based system. Since an increase in t_v will raise the marginal physical product of x_v, the incentives for subsidizing x_v will be greater for a time-based system Thus while work inputs may be subsidized under both time-based and fixed income systems, we would expect somewhat more subsidization under a time-based system, ceteris paribus.

Ideally, a partial price subsidy on x_v would be optimal. In practice, physicians often choose between no subsidy (no admitting privileges) or a complete subsidy. Given monitoring costs, this may be efficient, but clearly a complete subsidy encourages overuse. One solution is to set a maximum level of free

x_v. In many cases, however, the physician may have better information as to the optimal level of x_v, and thus the employer may wish to let the physician determine the use of x_v.

The problem then becomes to determine which work inputs are to be completely subsidized. A total subsidy will be relatively attractive when the derived demand function for the input is highly concave to the origin, as would occur with a fixed-proportion work production function. By contrast, if Cobb-Douglas production functions are assumed, a total subsidy will lead to infinite useage since the derived demand curve is convex to the origin and never crosses the x_v axis.[6]

Finally, we have not indicated any reason other than simple X-inefficiency why any physicians should be found in any remuneration system other than output-based income. One possibility is that output-based income involves significantly greater monitoring costs. Records of medical care delivered must be collected and recorded. In situations such as teaching where that product is difficult to define and record, the otherwise suboptimal fixed income may be more efficient (especially if the degree of work-loving is high).

A second reason which may lead to other remuneration systems is the riskiness of output-based incomes. Young physicians with large debt services are especially likely to be risk averse and willing to take a certain income rather than to assume the riskiness of an output-based remuneration with a larger expected-value.

V. Data and Testable Hypotheses

The 1976 HCFA/NORC Survey of Physician Practice Costs and Income includes a telephone survey of 3482 office-based physicians in fifteen specialties and in solo or small group practices. The data include indications of salary, fee-for-service, expense sharing, income equalizing, and prepaid remuneration types. They also contain measures of a good variety of physician practice inputs and expenditures, physician work times, and physician-patient contacts. The original questionnaire file has been expanded to incorporate the socio-economic-demographic information on each physician's county of practice.

Because own gross practice income is reported for only salaried, solo physicians (who may share expenses), and unincorporated groups (who also may share expenses), the empirical section of this paper focuses on these three remuneration types. Additionally, we restricted the number of specialty categories to the largest six in order to not exhaust computer memory in our tests for interaction effects among the independent variables. These restrictions reduce the sample down to between 800 and 1000 physicians, depending upon the dependent variable.

A. Dependent Variables

Our purpose is to estimate the effects of remuneration on income, practice inputs and medical care production. Although we recognize that gross income for fee-for-service physicans is conceptually different from that of a salaried physician, we estimate equations for both gross income and net income classes. We estimate equations for three measures of physician's time at work: patient office hours, hospital round hours, and total medical hours. We examine physician deductions from gross income as a measure of physician practice expenditures. And we use data on the number of patient office visits and physician hospital visits as alternative measures of the physician's medical care production. To test the model's predictions at an equal income, we examine each variable's value per $10,000 of physician's net income.

B. Independent Variables

The principal focus of this research is on the effects of remuneration alternatives. But fee-for-service and salary remunerations are not straightfoward applications of any of the alternatives considered in our model. For the purposes of this paper, we presume that real world fees of a fee-for-service system are determined by both the physician's time and by the medical care that is produced. Similarly, we assume that salary is some mix of fixed income and time-based income.

In the regression model, remuneration type 1's are physicians salaried by individual physicians. Type 2's are salaried by a group of physicians. Type 4's are solo physicians who share some expenses. Type 7's are unincorporated small groups who don't share expenses. Type 8's are unincorporated small groups who do share at least some expenses.

With these definitions of fee-for-service and salary remunerations, and with attention focused on the time, practice expenditures, and medical production data available from the HCFA/NORC Survey, we derive the following empirically observable hypotheses. Compared with fee-for-service physicians, the salaried doctors should

1) earn less gross income;
2) work fewer hours, and fewer hours per dollar of net income;
3) have fewer practice expenses, and fewer practice expenses per dollar of net income; and
4) produce less medical care and less medical care per dollar of income.

Other independent variables include the physician's age and sex categories, possible status as a foreign medical graduate, and specialty code. We also examine the effects of the degree of urbanization of the county of practice. We anticipate income to be lower for the young and older physicians; but age seems less likely to affect work time or output. Convential wisdom suggests that females and foreign medical graduates may earn less than indicated by their time at work and work outputs. We include specialty categories to control for their effects on remuneration hypotheses. Readers may formulate their own hypotheses about different incomes, practice inputs and productivities among specialties.

VI. Empirical Results[7]

Our analyses estimate the effects of remuneration type on each dependent variable. In every equation, the intercept is the estimated value for the solo, male, fee-for-service, general (or family) physician who does not share expenses. In the following paragraphs we discuss the implications of salaried and fee-for-service groups, physcians' age, sex, and foreign medical graduate status.

There are a number of significant differences between the solo fee-for-service physician and doctors who are salaried employees of single doctors. The salaried physicians earn $27,200 and $14,000 less gross and net income. They spend 4.43 more hours per week on hospital rounds and 12.78 more hours in all aspects of medical care. They do not produce significantly different numbers of patient office or hospital visits. Per $10,000 of net income, they work 3.99 more office hours, 3.82 hospital hours, and 11.98 total medical hours and produce 5.69 more hospital visits per week. And their lower medical deductions confirm the expected lower levels of practice expenditures.

These results are not entirely anticipated by our model. Although our expected lower gross incomes and lower practice inputs are confirmed, salaried physicians of single doctors work longer hours and produce more medical care than the fee-for-service counterparts. We expected them to work fewer hours and produce less. However these unanticipated results are not duplicated by salaried physicians employed by a group of physicians. The group-salaried again earn less gross income and utilize less practice inputs than the fee-for-service doctors but are not significantly different from the fee-for-service doctors in their hours worked and medical produced.

One explanation for the unanticipated results and importance of the number of employing physicians is that the salaried-by-solo-MD physicians are young doctors who are on trial as potential partners in already established practices. But this hypothesis is not supported by our trial (unreported) interaction regressions in which the interaction or dummy variable for young salaried physicians is not significant.

There are no significant differences between the solo fee-for-service physicians and the fee-for-service solo practices that do share some expenses.

The unincorporated group physicians earn as much as $26,900 more gross and $20,700 more net incomes, have $46,300 more medical deductions, and make 13 to 25 more hospital visits per week than the solo fee-for service doctors.

The female variable generated a surprisingly strong series of coefficients. After controling for remuneration type, age, and specialty, female doctors earn $17,300 less gross income and $14,900 less net income than their male counterparts. This difference appears to be determined by 16 fewer office and 12 fewer hospital visits per week, but not by fewer office, hospital or total medical hours. Per dollar of net income per week, female physicians work 4 more office and 7 more total medical hours and see 7 more office patients (without making fewer hospital visits).

Physicians over sixty earn $11,400 to $28,500 less income, work up to 12 fewer hours, and see 10 to 28 fewer patients in both the office and hospital. Physicians over seventy spend 3.5 more office and 4.3 more total medical hours per dollar of net income.

Foreign medical graduates are observed to spend less on deductable office expenditures and to see 12 fewer patients in the office per week.

VI. Summary

This manuscript introduces a model of physician behavior under three alternative remunerations: output-based, time-based, and fixed incomes. We demonstrate the efficiency properties of output-based incomes: physicians will prefer output-based income if employers impose equal unit cost restrictions, and employers will prefer output-based income if physicians move between remuneration systems until their utilities are equal. By presuming that fee-for-service remuneration is at least partly based on medical care produced and that salary remuneration is in part a fixed remuneration, we derive hypotheses of less income, time at work, and work expenditures for salaried physicians. Our data from HCFA's Survey of Practice Costs and Income support the lower income, but indicate that salaried employees of single physicians work longer hours and make more patient visits per dollar of income. The data also indicate substantially lower incomes for female physicians, ceteris paribus.

FOOTNOTES

* This Research was supported by Contract 500-78-0055 between the Health Care Financing Administration, DHEW and Washington University, St. Louis, MO. The views and opinions expressed are the authors'. No endorsement by HCFA or DHEW is intended or should be inferred.

1 We assume that the quantity/quality trade-off is independent of the remuneration method.

2 Assume $p_x = p_x$.

3 A fourth alternative, capitation or prepayment, is excluded from this paper for the lack of accurate empirical measure of those physicians who accept capitation payments.

4 While the Cobb-Douglas functional forms significantly simplifies the algebra, they may also introduce results which would not be robust for other functions. The implications of relaxing the unitary elasticity assumptions are considered in the final section.

5 One incentive for supplying x_v, of course, is to reduce physicians' income taxes. Nevertheless, the income tax incentive exists only if the individual takes the standard deduction and if the expenditures would not be otherwise deductable from personal income. Thus we do not believe income taxes are an important rational for physician's free access to hospital services in most cases.

6 In addition, a subsidy will lead to overuse when x_v can also be used to produce leisure goods or if the employee has a preference for x_v intensive outputs.

7 The authors apologize for not being able to fit the emprical estimations within the 6 page limit. The full manuscript is availble from R. Woodward, HAPP, 724 S Euclid, St Louis, MO 63110

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TABLE 1.

Endogenous Variable Solutions for Three Remunerations
Cobb-Douglas Model with Constant Returns to Scale

Endog. Var.	Fixed Income		Time Based Income		Output-Based Income
t_z	$\frac{\alpha\gamma T}{\alpha\gamma+\beta(1-\gamma)}$	>	$\alpha\gamma T$	=	$\alpha\gamma T$
t_v	$\frac{\beta(1-\gamma)T}{\alpha\gamma+\beta(1-\gamma)}$	<	$(1-\alpha\gamma)T$	=	$(1-\alpha\gamma)T$
x_z	$\frac{(1-\alpha)\gamma Y}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}$		$\frac{(1-\alpha)\gamma}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}(1-\alpha\gamma)wT$		$\frac{(1-\alpha)\gamma\beta}{(1-\beta)}T[P(1-\alpha\gamma)]^{\frac{1}{\beta}}\left(\frac{1-\beta}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}}$
x_v	$\frac{(1-\beta)(1-\gamma)Y}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}$		$\frac{(1-\beta)(1-\gamma)}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}(1-\alpha\gamma)wT$		$TP^{\frac{1}{\beta}}(1-\alpha\gamma)^{1+\frac{1}{\beta}}\left(\frac{(1-\beta)}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}}$
Y	Y		$(1-\alpha\gamma)wT$		$T[P(1-\alpha\gamma)]^{\frac{1}{\beta}}\left(\frac{(1-\beta)}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{\frac{1}{\beta}-1}$
Z	$\left(\frac{\gamma\alpha T}{\alpha\gamma+\beta(1-\gamma)}\right)^{\alpha}\left(\frac{\gamma(1-\alpha)Y}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\alpha}$		$(\alpha\gamma T)^{\alpha}\left(\frac{(1-\alpha)\gamma(1-\alpha\gamma)wT}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\alpha}$		$(\alpha\gamma T)^{\alpha}\left\{\frac{\gamma\beta(1-\alpha)T}{(1-\beta)}\left[\frac{P(1-\alpha\gamma)(1-\beta)}{(1-\beta)+\gamma(\beta-\alpha)}\right]^{1/\beta}\right\}^{(1-\alpha)}$
V	$\left(\frac{\beta(1-\gamma)T}{\alpha\gamma+\beta(1-\gamma)}\right)^{\beta}\left(\frac{(1-\beta)(1-\gamma)Y}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\beta}$		$((1-\alpha\gamma)T)^{\beta}\left(\frac{(1-\beta)(1-\gamma)(1-\alpha\gamma)wT}{(1-\alpha)\gamma+(1-\beta)(1-\gamma)}\right)^{1-\beta}$		$T(1-\alpha\gamma)^{1/\beta}\left[\frac{(1-\beta)P}{(1-\beta)+\gamma(\beta-\alpha)}\right]^{(1/\beta)-1}$
$\frac{Y}{V}$	$\frac{[\alpha\gamma+\beta(1-\gamma)]^{\beta}[(1-\alpha)\gamma+(1-\beta)(1-\gamma)]^{1-\beta}Y^{\beta}}{(1-\gamma)\beta^{\beta}(1-\beta)^{1-\beta}T^{\beta}}$		$w^{\beta}\left[1+\frac{(1-\alpha)\gamma}{(1-\beta)(1-\gamma)}\right]^{1-\beta}$		P

TABLE 2: Ranking of Endogenous Variables for Equal Physician Utility, Equal Physician Gross Income, and Equal Unit Cost of Medical Care

Endogenous Variable	Market Assumption	Ranking		
		Largest	Intermediate	Smallest
U utility	equal utility	[	EQUAL BY ASSUMPTION	]
	equal income	fixed	output-based	time-based
	equal cost	output-based	time-based	fixed
Y gross income earned	equal utility	output-based	time-based	fixed
	equal income	[	EQUAL BY ASSUMPTION	]
	equal cost	output-based	time-based	fixed
Y/V unit costs of work output	equal utility	fixed	time-based	output-based
	equal income	fixed	time-based	output-based
	equal cost	[	EQUAL BY ASSUMPTION	]
t_z leisure time	all types	fixed	[output-based =	time-based]
t_v work time	all types	[time-based =	output-based]	fixed
x_z net income or leisure expenditures	equal utility	time-based	[fixed >,=, or <	output-based]
	equal income	[time-based =	fixed]	output-based
	equal cost	time-based	fixed[1]	
x_v practice inputs (work expenditures)	equal utility	output-based	time-based	fixed
	equal income	output-based	[time-based =	fixed]
	equal cost	output-based	time-based	fixed
Z leisure activities consumed	equal utility	fixed	time-based	output-based
	equal income	fixed	time-based	output-based
	equal cost	[all ranks depend upon parameter values]		
V work output produced	equal utility	output-based	time-based	fixed
	equal income	output-based	time-based	fixed
	equal cost	output-based	time-based	fixed

[1] Output-based income's rank depends upon the parameters. Solutions available from the authors.

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